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ENTOMOLOGY 19

GRAPEVINE ROOT WORM

BY

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GRAPEVINE ROOT WORM

PREFACE

The grapevine root worm has proved itself such a destructive enemy of vineyards in the Chautauqua grape belt, and so little success has attended efforts to control it, that it was deemed advisable in 1902 to undertake an investigation of this insect. The work of last year was embodied in Museum bulletin 59, and the material additions to our knowledge of this pest, gained in 1903, have rendered it advisable to issue an extended and revised edition of our previous publication, because the subject is of such vital importance that our growers should have all available information at their disposal. Many valuable facts have been ascertained during the last two seasons; and the additional data gained in 1903 demonstrate the value of timely cultivation and prove that collecting the beetles is practical, the most reliable and probably the most economical method of controlling this very serious enemy of the vine.

Through the courtesy of the Hon. C. A. Wieting, commissioner of agriculture, the entomologist has been able to avail himself of the services of nursery inspector J. Jay Barden who has cooperated with the writer very efficiently, and most of the field investigations were carried on with the assistance of this gentleman. Acknowledgment is due Mr D. K. Falvay of Westfield, who kindly placed a portion of his excellent vineyard at our disposal and cooperated with us most efficiently, thereby not only benefiting himself but aiding materially in demonstrating a practical

method of controlling this pest, after it had become well established in a vineyard. The breeding cage and other office experiments have been conducted under the writer's direction by his first assistant, Mr C. M. Walker, aided by the second assistant, Mr D. B. Young. The author is also under obligations to Prof. Percy J. Parrott, entomologist of the Ohio Agricultural Experiment Station, and Prof. A. F. Burgess, chief San José scale inspector of Ohio, who kindly accompanied him in his investigation of conditions in that state in 1902 and supplied additional information in 1903.

E. P. Felt

Albany N. Y. September 1903

GRAVEVINE ROOT WORM

Fidia viticida Walsh

Ord. *Coleoptera* Fam. *Chrysomelidae*

INTRODUCTION

The control of this pest in the Chautauqua grape belt is a serious problem which we have attempted to solve. The insect has, in recent years, caused enormous damages in the Ohio grape belt and now occurs in large numbers in Portland, Westfield and Ripley and has obtained a foothold over a large area. Messrs Walter Northrop and F. A. Morehouse estimated in the spring of 1902 that over 80 acres of magnificent vineyards had been destroyed or ruined by the pest in the vicinity of Ripley, and our investigations at the present time show that the area of severe injury and damage is constantly increasing, and is liable to much greater extension in the next few years. We consider this insect a much more serious enemy of the vineyard than the well known grapevine leaf hopper or white fly,[1] the work of which was so apparent and destructive in 1902 and the preceding two or three years. This leaf hopper undoubtedly causes much mischief, but, as its operations are confined to the leaves, the amount of damage is easily seen and, when necessary, steps may be taken to control it. The root worm on the other hand inflicts its most serious injuries under ground, where its operations can not be readily observed, and in a great many instances a vine or an entire vineyard is entirely ruined before the grower observes any trouble. This pest only requires two or three years to ruin a vineyard; and this, in connection with the secrecy of its work and the feeding of the grubs on the large roots, where a small amount of girdling is fatal, renders it a most dangerous enemy. Worst of all, this insect exhibits a decided preference for the more thrifty vineyards and is found most abundantly on or beneath the most vigorous vines. We believe that 15 or 20 grubs about a vine or as many beetles on its foliage are sufficient to warrant the adoption of vigorous measures for the suppression of the pest, though we are well aware that many more are fre-

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[1]Typhlocyba comes var. vitis Harris

quently seen in a vineyard still alive. The marvelous prolificacy of the insect, as demonstrated by our studies, justifies the belief that even a relatively small number are sufficient to threaten the welfare of a vineyard.

The season of 1902 was unusually favorable to vine growth, and the same is true of the past summer, a condition for which the grower should be thankful, since it has enabled the vines to withstand insect attacks more successfully.

Area infested. Ripley appears to be the original center of this insect's most destructive work, though it has been found generally present in small numbers in many vineyards where little evidence of serious injury occurs. The pest very probably made its way into the Chautauqua grape belt from Ohio; and our investigations in 1903 show that it is present in greater or less numbers from the state line as far east as Sheridan, if not farther and from the lake shore to the top of the adjacent hills. We have also found it in small numbers in Hudson river valley vineyards at Highland and Milton.

Signs of the insect's presence. The more destructive work of this pest is somewhat difficult to detect, and is usually indicated by a weakness in vines and a marked decrease in the amount of new wood. The indications of the presence of the beetles are so characteristic that there should be little trouble in locating them. The peculiar chainlike eaten areas, represented in numbers on plate 6, are very characteristic of the insect and differ so much from the work of most other pests that no difficulty should be experienced in identifying it. The beetles show a decided preference for leafy vines, and the general appearance of some very badly eaten ones is shown on plate 5. The feeding of the beetle is usually the first visible indication of its presence and is not accompanied at the outset by signs of material injury. As the attack progresses and the work on the roots becomes more injurious, the development of the fruit is severely checked and the bunches may be less than half their normal size. The growth of wood is also much reduced, and vines which are very badly infested may die in midsummer. Cases were brought to the writer's attention where plants which had grown over 6 feet of wood the preceding summer, wilted in June and died. Infested vines as a general thing become less thrifty, develop less and

less wood yearly till finally there is not enough to tie up. A portion of a vineyard very seriously injured and where there is not wood enough to tie up is represented on plate 3. This condition rapidly becomes worse, and soon, usually in two or three years after the insect has been present in numbers, there is no wood, and the vines are simply a small mass of foliage resting on an old stump as represented on plate 4.

The depredations of this pest are much more serious and usually first apparent on light sandy or poor soils, and in particular on gravelly knolls, though we have found the beetles much more abundant in rich, low, though not wet hollows. The insects seem to thrive under such conditions, and a deficient growth should lead to immediate investigation. Vines on rich clay soils in our experience are less injured by this pest, due probably to their greater resistant powers; and this appears to be the case in Ohio. It should be remembered that vineyards on heavy clay lands are not exempt from attack and should be closely watched and, if necessary, active measures employed to keep the number of beetles below the danger point.

The roots also afford a clue to the identity of the depredator. The young grubs eat away the small feeding branches, while the larger individuals gnaw the bark, particularly from the underside of the larger roots. They frequently eat away long strips, as represented on plate 1, figure 5, though occasionally a single grub may work along a somewhat sinuous path.

A native species. This serious pest of the vineyards is not, like many of the forms so injurious to agriculturists, an imported insect. It has long been known to occur in this country and its work on wild grapevines was observed before its depredations attracted notice in our vineyards. This insect may develop into a general pest of the grape and perhaps in time come to be as well known as the very destructive Colorado potato beetle, which is familiar to almost every farmer. It is very probable that this grape enemy was able to exist only in relatively small numbers on wild vines and hence was rarely very injurious. It seems to have developed a great fondness for some of our cultivated varieties, and the growing of these in large areas has enabled it to increase to an almost unparalleled degree. This may perhaps be cited as one of the cases

where the devotion of extensive tracts to one crop has resulted after years in a species formerly harmless becoming very destructive.

It is interesting to note in this connection that the insect is by no means new to New York State. There are examples of the beetles in the private collection of the late J. A. Lintner, which were taken in Schenectady in 1880 and on Virginia creeper at Albany in 1882, and yet so far as known there is no record of the species proving destructive in this section. The writer also met with the insect at Albany in considerable numbers on Virginia creeper in 1901, and, though he has frequently visited vineyards in the vicinity, no signs of the insect were observed. It is very possible that the death of vines in early years here and there may have been caused by this beetle and attributed by growers to other agencies, as was the case before Professor Webster discovered the identity of the depredator in Ohio.

Allies. This species belongs to the large family of leaf-eating beetles, known as the Chrysomelidae, a group which comprises some of our most destructive insects. To it belongs the notorious elm leaf beetle,[1] a species which has destroyed thousands of magnificient shade trees in the Hudson river valley, and may in a few years become a most serious enemy to elms in other sections of the State. The two asparagus beetles,[2] are well known enemies to the grower of this succulent vegetable. The familiar yellow and black striped squash bug[3] is another ally of this destructive grape pest, which is sometimes aided in its deadly work by the steely or grapevine flea beetle,[4] a species which has caused great injury in some New York vineyards during recent years. A number of other related forms, nearly as injurious as those named, could be easily listed. These destructive allies are mentioned in this connection simply that the grape grower may have some idea of what related species can do; and, while this pest may not prove so generally injurious as any of these, it has already demonstrated its ability to cause much mischief. We see no reason at present for thinking that the history of this

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[1] Galerucella luteola Müll.
[2] Crioceris asparagi Linn. and C. 12-punctata Linn.
[3] Diabrotica vittata Fabr.
[4] Haltica chalybea Illg.

insect in Ohio may not be duplicated in the Chautauqua grape belt, and perhaps in other sections of the State where this fruit is largely grown.

Present conditions in Ohio. The destructive work of this serious pest has been known in Ohio for some years. It was first brought to the attention of Professor Webster in 1893. The similarity of conditions existing between the Ohio grape belt and the Chautauqua region led the entomologist to believe that valuable data could be secured by personally investigating the present status of the insect in Ohio. This interesting section was visited about the middle of September 1902, and much valuable information secured through the kindly cooperation of Prof. P. J. Parrott, entomologist of the Ohio Agricultural Experiment Station, Prof. A. F. Burgess, chief San José scale inspector, and a number of prominent growers. The local knowledge of conditions possessed by the two gentlemen named enabled us to visit the sections of most importance with very little loss of time. Some very precise and significant statements were obtained in 1902 from Mr T. S. Clymonts of Cleveland O., who is not only a grower but also a dealer and one who undoubtedly has as good a general knowledge of local conditions as any one in that section. He stated that in the Ohio belt, extending east and west of Cleveland, from Painesville to Avon and reaching back 5 miles from the lake, there had been a reduction in shipments of fully two thirds during recent years. In 1894, 2000 carloads of grapes were shipped from that section. This was reduced in 1900 to 900 and in 1901 to 600. Mr Clymonts estimated the output for 1902 at not over 500 carloads.

He stated that this reduction is due to various causes, the principal ones being the ravages of the grape root worm, the destruction caused by rot, and the prevailing low prices. He attributed fully one third of the entire reduction to the beetles' work and instanced a number of cases where vineyards of considerable size had been killed by the operations of this pest. He mentioned one vineyard of 60 acres, another of 25 acres, and stated that innumerable small pieces had been destroyed by the work of this insect, and added that the yield of one 60 acre vineyard had been cut from 10–12 carloads to 35–40 tons by its

operations. Mr Clymonts's observations led him to think that as a rule the younger vineyards, specially those planted in the last 10 or 12 years, suffered most, and that the old ones escaped with comparatively little harm. The most destructive work observed by him had been on sandy soil, or on ridges in other pieces. He also stated that vines set in an infested vineyard to fill vacancies do not thrive and are usually killed by the insect. A recent communication, Aug. 27, 1903, states that nothing has developed the present year to make it advisable to modify any of the above statements.

Mr J. W. Maxwell of Euclid stated in 1902 that 50% of the vineyards were dead in that section, and that in his opinion a large proportion of them died as a result of the operations of this insect. His crop of grapes in a large vineyard was reduced fully one fourth, the most of which he attributed to this pest. He stated that the Wordens and Brightons were killed first, while the Concords and Catawbas were not so badly injured. He also adds, in a letter dated Aug. 29, 1903, that renewing a vineyard with Niagara vines seems to be quite a success, since 800 roots set two years ago in vacancies all lived and have done well. We hope this will continue to be the case, but in the writer's opinion these recently set vines have just reached a very attractive condition, so far as the beetle is concerned, and he is afraid that injury may result in a year or two.

Mr W. H. Slade of East Cleveland estimated in 1902 that one fourth of the vineyards in that section had been destroyed by this insect pest, and according to his observations the Wordens and Catawbas suffered more than the Concords. The most serious damage in his experience was met with on the lighter soil of knolls.

Mr W. W. Dille of Nottingham was of the opinion in 1902 that there has been a decrease in recent years of 40% in the area devoted to grapes. He attributed this shrinkage about equally to the rot, which had been very prevalent, to the operations of the grape root worm, and prevailing low prices. He stated that the insect injuries had been limited mostly to the bluff and to vineyards in the near vicinity of the lake shore, those back and just under the bluff escaping with comparatively little damage. He considers the Concord as one of the most resistant varieties.

A number of other growers were interviewed in 1902, and some disparity of opinion naturally prevailed. It will be seen, however, that there are a number of well informed men in that section who attribute very serious injuries to this insect; and, while the estimates of some may be excessive, there can be no doubt that the pest has caused very serious losses. The season of 1902 was unfavorable for observing the work of this pest because the repeated rains enabled the vines to sustain much greater injury than they would in times when there was less moisture. These conditions prevented the making of personal observations on the destructiveness of the insect, and most of our data relating to this had to be obtained from the evidence of others.

Considerable attention was also given to the various remedial measures employed by different growers, and some diversity of opinion existed. A number had sprayed their vines with arsenate of lead and also with bordeaux mixture. A few were of the opinion that spraying with arsenate of lead is a very efficient check on the increase of the insect, while others believed that it was of comparatively little value. Mr T. S. Clymonts stated that spraying with the bordeaux mixture alone affords some protection, as the beetles migrate to untreated vines. This subject will be discussed more at length under "Remedial measures." Most of the growers agree that thorough cultivation assists the vines greatly in resisting the depredations of the grubs. Those on whose premises carbon bisulfid was used were not favorably impressed with the substance. They state that in any event the cost of application is excessive considering the prevailing low prices for grapes. Considerable injury was caused in certain vineyards by carbon bisulfid, and it is very doubtful if this measure can be used to advantage.

Early history. This insect was first brought to notice in 1866 when specimens were sent from Kentucky to Mr B. D. Walsh, afterward state entomologist of Illinois. This gentleman stated at the time that he had taken the beetle in small numbers in both north and south Illinois, and later in the same year described the species. He also received the insect the following year from St Louis and Bluffton Mo., where the adults were said to be eating both foliage and fruit. Prof. C. V. Riley, in his first

report on the *Injurious and Beneficial Insects of Missouri*, characterizes this species as one of the worst foes to the grapevine in Missouri. This condemnation was based solely on the operations of the beetle on the leaves, an injury which is now regarded as of little importance compared with the work on the roots. Professor Riley received specimens from Bunker Hill Ill. in 1870, and in 1873 Mr G. R. Crotch described the insect[1] and gave its recorded distribution as the Middle and Southern states. The identity of the species described by Mr Crotch and this insect was pointed out by Dr Horn in 1892, when he recorded its distribution as the "Middle states to Dakota, Florida and Texas." He also states that the insect described by Lefevre[2] belongs to this species. This pest was received from the vicinity of Iowa City Ia. by Prof. H. F. Wickham in 1888, and Professor Riley has recorded this form and an allied one[3] as injuring grape leaves at Vineland Ark.

Nothing further was known regarding this species till 1893, when specimens were sent to Prof. F. M. Webster, then of the Ohio Agricultural Experiment Station, who made an exhaustive study of the insect and published a detailed account of his investigations in 1895.

Injuries by this insect in the state of Arkansas were recorded by Prof. J. T. Stinson in 1896, and in the same year Professor Webster notes a decrease in the numbers of the pest in Ohio vineyards and attributes it as possibly due to the efficient work of two egg parasites and a small mite.[4] The following year Messrs Webster and Mally reported, as a result of a series of experiments, that tobacco dust and kainit were practically ineffective against this insect, and two years later these gentlemen record the unusual abundance of the pest in Ohio vineyards, and state that serious injuries occurred at Bloomington Ill. The presence of this beetle in destructive numbers in the Chautauqua grape belt was recorded by Prof. M. V. Slingerland in 1900, who at that time published a general compiled account of the insect. Dr J. B. Smith, in his *Catalog of the Insects of New*

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[1] Fidia murina Crotch
[2] Fidia lurida Lefevre
[3] Fidia longipes Melsh
[4] Heteropus ventricosus Newport

Jersey states that this species occurs throughout New Jersey on the grape and Virginia creeper or Ampelopsis, and he also records it from Staten Island. A brief note published by Dr L. O. Howard in 1901 states that the depredations of this insect at Bloomington Ill. continue unabated and severe damage to vineyards is recorded. The writer, in the early spring of 1902, published a brief notice of the extent of the injuries in the Chautauqua grape belt with a summary of the life history of the pest and outlined a series of experiments for that year, which are reported on in detail in this bulletin together with the results obtained in 1903.

DESCRIPTION

The perfect insect is a small, brown, rather robust beetle about $\frac{1}{4}$ inch in length and rather densely covered with short grayish white hairs. It may be recognized by aid of plate 1, figure 1.

The egg is about $\frac{1}{25}$ inch in length with a transverse diameter about one fourth as great. Form, nearly cylindric, tapering a trifle at each end. The shell is flexible, and, when a number of eggs are crowded in a small space, they may become somewhat distorted. The eggs are white when first deposited, but soon assume a yellowish cast. On the fourth day a narrow semitransparent band appears near each end. The eggs of the clusters normally have a somewhat concentric arrangement, and range in number from 1 to 125. Several clusters are represented on plate 1, figure 3.

The young larva is creamy white, about $\frac{1}{17}$ inch in length and tapers somewhat posteriorly. The head is a pale, yellowish color with the mouth parts ranging from light to dark brown, the sutures and tips of the mandibles having the most color. The head is somewhat flattened, bilobed and with the posterior angles rounded. The mandibles are distinctly toothed. The body is slightly smaller than the head, convoluted and distinctly segmented. Each segment bears a transverse row of small tubercles, from each of which a long hair arises. The spiracles, or breathing pores, are darker than the body and usually light yellow.

The nearly full grown grub resembles the newly hatched individuals very much in general form and color. It is then

about $\frac{5}{8}$ inch in length, with a yellowish brown head and the mouth parts and adjacent sutures dark brown or nearly black. The body has a greater transverse diameter than the head, is distinctly segmented and bears numerous irregular transverse rows of small setae, which are relatively much shorter than in recently hatched individuals. The spiracles are well marked and range in color from yellowish brown to light brown. The general appearance of the grub is shown on plate 1, figure 4. Its white color and curled form suggest the common white grub, in spite of its much smaller size.

The pupa ranges in length from about $\frac{1}{4}$ to $\frac{1}{3}$ inch and its general features are represented on plate 1, figure 6. It may be recognized by its white color with a pinkish tint about the head, thorax and posterior extremity. The head is adorned with a semicircular row of four spines, the middle two being larger and nearly erect, the others smaller and more divergent. There is a similar row near the anterior margin of the thorax, though the curve is not so pronounced as on the head. Just behind this latter row there is a cluster of four smaller, nearly erect spines placed in pairs, the posterior being more widely separated. The anterior femora is armed at its tip with a stout hook, while above and at one side is a single straight, hair-tipped spine with sometimes a second one below. The posterior femora is likewise armed with a stout hook and with two hair-tipped spines. At the posterior extremity, there are two flattened, stout spines projecting dorsally. The penultimate segment is armed with a pair of small, median spines with a smaller pair of closely placed ones on each side, and on the antepenultimate there is a median cluster of four closely placed, hair-tipped spines, the inner two being smaller. There is also a lateral spine on each side [fig. 1]. The other segments are each provided with a single transverse row of minute, short bristles, and on the scutellum there is a median pair of larger ones.

FIG. 1 Posterior segments of pupa (original)

This pupa may be known by its general form and coloration, and by the peculiar arrangement of the spines at its posterior extremity, as shown in the figure.

LIFE HISTORY

The life history of this insect may be summarized as follows: The winter is passed by the nearly full grown grubs in oval cells in the soil, and so far as our observations go the great majority of them occur from 10 to 12 inches below the surface and mostly near or in the subsoil. On the approach of warm weather, the grubs work upward, probably early in May in most years, and are then mostly within a few inches of the surface and usually within 15 to 24 inches of the stem of the grapevine, though some, and occasionally large numbers, may be found near the middle of the row. Usually very little feeding is done in the spring. The transformation to the pupa occurs in normal seasons from about June 1 to 20, the adults issuing approximately two weeks later or from about June 20 onward. The great majority of the beetles appear the last of June or early in July, though some do not emerge till the last of the month and in rare instances much later. A pupa was met with Aug. 15, 1902, and the adults have been found in New York vineyards as late as September and even in October. The latter are probably from belated larvae. The eggs are mostly laid in July and August under the loose bark of last year's wood and require a period of about two weeks to hatch. The young grubs make no attempt to crawl down but drop, and working under the loose soil make their way to the small feeding roots, where under favorable conditions they grow rapidly and after increasing considerably in size attack the larger roots, eating away long strips of the bark [pl. 1, fig. 5]. The latter, when a large number of grubs are present, may rest simply on a bed of borings. Many of the grubs attain nearly full size the latter part of August or early in September. Late in the fall the larvae descend to considerable depths, as previously noted, construct their oval cells and pass the winter within them.

Habits of the beetle. The habits of the beetle are of special interest because it is practicable to collect these insects and thus in a large measure prevent egg-laying and consequent damage from the grubs. Professor Webster states that the beetles normally begin to appear in northern Ohio about June 20. This agrees closely with our observations. The season of 1902 was remarkably late, and very few beetles were observed previous to

July 2, while in 1903 a few were taken June 19. Their first appearance was on light soil, and the insects did not begin to emerge in numbers on heavy land till nearly a week later. Our cage experiments [*see* table on p. 27] show that over 92% of the beetles appeared within two weeks after the first were taken, and practically none after July 21. In other words, out of 506 bred from under two vines, 477 emerged by July 21. The issuing of the insects is undoubtedly considerably modified by temperature, as demonstrated by the beetles appearing in unusually large numbers on the 26th, which was a bright, warm day. The time of appearance and the fact that a large proportion of the insects issue from the ground within two weeks are of much importance, if anything is to be done by collecting the insects. The beetles appear to emerge and remain on the foliage, particularly around buds, several days before they feed to any extent. Breeding cage experiments have fixed this period at from one to four days. Two beetles which actually emerged under observation refused food till the fourth day, and it is very probable that this period is nearly the normal time between the emergence of the beetles and feeding. A considerable number may be found before any feeding has taken place, as is evidenced by Mr Barden taking 12 from a vine which bore practically no marks of their eating. The insects may be found in a field over an extended period, which is not surprising in view of the fact that a beetle may live over nine weeks, as demonstrated by us this year. Some were observed by Mr T. T. Neill Sep. 4, 1902, in a vineyard at Fredonia, and Mr F. A. Morehouse states that he met with individuals in October 1902.

Oviposition does not occur till some days after the appearance of the perfect insects, and according to breeding cage observations this period may range from 10 to 17 days. Our breeding cage experiments also indicate that the insect may feed from 6 to 13 days before eggs are deposited. This period was carefully ascertained by isolating a series of males and females and providing them with as nearly natural conditions as possible. Both of these periods are much longer than normal, since eggs were found by Mr Barden in the Northrop vineyard July 9, 1902, where beetles were present in very small numbers on the 2d. This allows a maximum of only seven days between the appear-

ance of the earliest insects and the laying of eggs; and, if, as can hardly be questioned, the insects remain without taking food for two or three days, then the time of feeding before the deposition of eggs can hardly exceed an equal period. The first beetles were observed in 1903 on June 19, and a few contained nearly developed eggs July 2, at which time it was very warm and there were many pairing, and eggs were deposited a day or two later, making about two weeks between the appearance of the first beetles and the deposition of eggs. This period is a little longer than was the case in 1902, but even then does not equal our breeding cage records. This matter is of considerable importance because it shows how quickly collecting must be done or poisons must act in order to prevent the deposition of many eggs.

The feeding of the beetles occurs almost entirely on the upper surface of the leaves and, as described by Professor Webster, "is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upwards, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way, they move to another place and begin again, thus eating out numerous chainlike rows of silk net" as shown on plates 5 and 6. "The insects usually eat only to the lower epidermis on foliage having a velvety undersurface, but on others they eat entirely through the leaf." The beetles are shy and retiring by nature and feed largely in sheltered places or among the growing tips, both difficult places to hit with a spray. A favorite retreat of the insects is among the tendrils clinging to the top wire. Many of those feeding on the leaves are easily frightened, and when alarmed usually fold up their legs and fall to the ground, where they remain quiet till all danger appears to have passed. They can spring readily either with the legs or when inverted by suddenly opening the wing covers and projecting themselves from the hand or other support. The beetles on the canes, however, are not so easily disturbed. They can frequently be picked from the vine, and it requires repeated jarring to dislodge all. This is of considerable importance when collecting beetles with any machine, and the persistence with which some hang to the wood is an objection to this method of

controlling the insect. They are, however, much more easily jarred from the vines on warm days.

The tendency of this species to remain in a locality for a time, at least, is well shown in a certain vineyard at Ripley. It had suffered very severely in earlier years from the depredations of this pest and a portion of it was uprooted in the spring of 1902. A small area was allowed to remain in the hope that it could be brought back to a normal condition. A few rows next to the uprooted area were fed on to a very great extent by the beetles, which had evidently emerged from the adjacent soil and made their way to the nearest vines, where they were content to remain and feed. The extensive injury inflicted on these vines is well illustrated on plate 5, which shows how badly many of the leaves were riddled. A curious fact in connection with the abundance of the beetles on these small vines is that few or no eggs could be found, probably due to the small amount of wood. Observations have shown that while there is undoubtedly a connection between the amount of feeding and the number of eggs laid, such is not necessarily true of the feeding and the number of eggs or grubs on particular vines. This is a matter of some importance because many growers are inclined to estimate the number of grubs at the roots by the amount of feeding on the foliage, whereas it frequently occurs that more grubs are found under vines with foliage but little eaten than under those which bear evidence of excessive feeding. This tendency of the insects to remain in a locality for a time is favorable to local control, since it gives an opportunity to destroy them by collecting before there is much dispersion. Such opportunities should be embraced promptly, because it is well known that at times the beetles fly to a considerable extent. Mr Schonfeldt has called the writer's attention to an instance where numbers of the insects suddenly appeared on some vines close to his house. They were so numerous that the rattling as they struck the foliage attracted the notice of Mrs Schonfeldt, who called her husband's attention to the sound. The day was warm, and consequently the beetles flew rapidly. As a rule, we believe, dispersion occurs more by a wandering individual flight than by movements in swarms. There is a marked tendency among the beetles to desert unthrifty vines, probably because of the poor shelter they offer, and to attack the

more vigorous, thrifty vineyards. It may be that a slight overcrowding, as in the case of some other insects, impels the beetles to flight. This means that poor vines are relatively safe, while the better ones are liable to injury and are consequently the places where it is most important to control the insect. These inflying beetles will lay eggs if conditions are favorable, and the earlier they appear the more eggs will be deposited.

Eggs. The eggs of this insect are deposited almost entirely under the loose bark of last year's wood, many being found as high as the top wire. Professor Webster states that over 700 have been taken from a single vine, and from a section 16 inches in length and an inch in diameter he took 225 eggs. Once he found a few eggs pushed down between the earth and the base of the vine, but we have failed to find eggs in any such position. Beetles in confinement deposited eggs in crevices and cavities of the wood and even on leaves. Eggs were found in the field in 1902 as early as July 9, and oviposition was still in progress Aug. 15, and, though beetles were less abundant than three weeks before, it was still easy to find individuals which contained fully developed eggs. The first deposited in 1903 were found about July 3, and in our indoor breeding cages oviposition continued till into September. Experiments were planned, both this year and last, to determine the duration of the period of oviposition, the time when the eggs were laid and the total number deposited by females. A number of pairs of beetles were isolated and provided daily with fresh food. The work in 1902 demonstrated that a number of beetles might continue to deposit eggs for a period of over 40 days, and certain individuals from seven to 13 days. These records gave totals of 187, 141 and 106 eggs for individuals. This was interesting, but it was felt that the limit had not been reached, and consequently the studies were conducted on a more extended scale this year, and the results more than justified the labor, as will be seen by the appended table.

Oviposition experiments with Fidia 1903

Beetles taken at Westfield July 2

		Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant
July	4	30	....	....	(40♀)	(17♀)	(4♀)
	5	20	....	....	77	....	....
	6	21	....	....	25	....	....
	7	26	....	....	225	....	....
	8	20	....	....	30	75	....
	9	25	....	35	450	150	145
	10	35	....	....	300	175	40
	11	25	....	....	400	150	....
	12	30	....	10	650	100	....
	13	25	....	10	200	250	50
	14	....	....	....	150	40	25
	15	31	....	....	175	45	....
	16	....	140	....	30	....	150
	17	....	....	....	100	....	....
	18	33	25	....	175	125	25
	19	....	....	....	120	....	25
	20	....	....	....	20	....	50
	21	24	....	....	62	175	70
	22	....	....	75	25	10	40
	23	41	....	....	30	35	....
	24	30	....	26	200	50	75
	25	....	....	....	264	50	85
	26	24	....	....	185	300	160
	27	30	....	....	70	25	25
	28	....	....	....	62	....	....
	29	20	....	....	50	....	50
	30	....	....	....	130	50	50
	31	10	25	....	185	115	128
August	1	42	60	....	25	105	54
	2	....	....	....	....	50	70
	3	....	20	....	150	....	75
	4	11	....	All dead.	....	76	....
	5	....	....	....	75	....	130
	8	....	....	....	75	....	....
	10	56	....	....	58	18	....
	12	*a*16	72	....	73	....	95
	13	2	....	....	123	....	83
	14	36	....	....	25	....	....
	15	....	....	....	36	....	....
	17	42	....	....	90	23	36
	19	....	....	....	60	....	....
	20	45	....	....	75	....	....
	21	....	....	....	35	....	35
	22	36	....	....	70	....	166
	24	25	All dead.	....	40	15	28
	26	....	....	....	39	....	....
September	2	56	....	....	....	....	....
	4	14	....	....	....	....	....
	6	31	....	....	....	....	....
	11	♀ dead...	....	....	....	....	....
Totals.....		902	342	156	5 664	2 199	1 955
Average per female........		......	......	....	141	192	488

a 4.30 p. [illegible]

An examination of the above record shows that one female taken July 2 began laying eggs July 4 and from then to the 13th deposited from 20 to 30 daily, and from the latter day onward the eggs were laid usually at intervals of one to several days, the periods of deposition being interspersed by intervals of feeding. There seems to be a very direct connection between the amount eaten and the number of eggs laid, which would be expected when it is remembered that a single female lived upward of two months and during that time deposited the enormous number of 902 eggs. This record is a striking testimony to the care bestowed on the insects by Mr Walker, who had charge of the breeding cage work. Analysis shows that 257, or over one fourth of the total number, were laid during the first 10 days, and 416, or nearly one half of the total number, in the first three weeks. This record is undoubtedly exceptional and probably approaches the maximum capacity of the insect, particularly in the field. It will be seen, however, that one other female deposited 342 and another 156 eggs, while averages of beetles kept in certain stock jars ranged from 141 to 192 and 488 to each female, and an average based on the entire record gives nearly 175 for each female. This indicates that our highest record, 902, may not be so very exceptional. A study of the entire number of eggs is not without interest, as it shows when the greatest number are deposited and consequently the time when the beetles should be destroyed in order to obtain the maximum benefit. A summarized table is given below.

Summary of oviposition record 1903

DATE	Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant	Total	Per cent of total
July 4–18	321	165	55	2 987	1 110	435	5 073	45
July 19–31	179	25	......	1 403	810	758	3 175	†28
July 4–31	500	190	55	4 390	1 920	1 193	8 248	†73
Totals, July–Sep.........	902	342	156	5 664	2 199	1 955	11 173	....
Average per female........	902	342	156	141	192	488	....	....

It will be seen from an examination of this that 5073 eggs were deposited by all of the different beetles in the various jars between July 4 and 18 (or the first two weeks) making a total of

45% of the entire number, and that only 3175 were deposited between July 19 and 31 (or the following 12 days). It will also be observed that 8248 eggs were deposited by all the beetles during the month of July, and this amounts to over 73% of the entire number produced by the beetles under observation. In other words, a very large per cent of the eggs are deposited under normal conditions during the first two weeks after the beetles begin to lay, or during the first three or three and one half weeks of their existence. There is then a decided drop during the next 10 or 12 days, and a much greater falling off in the following weeks. This record probably represents very closely indeed what actually occurs in the field and emphasizes the necessity of destroying the insects early in their career, though it will be observed that considerable protection results even if the pests are not killed till three or four weeks after they appear above ground.

The beetles which made the records both this year and last were confined in jelly tumblers or fruit jars and were daily supplied with small pieces of cane and fresh leaves. Careful records were kept of all insects taken from the individual tumblers as well as the large breeding jars, and, while the conditions were by no means normal, it is manifest that valuable results were obtained. In nature, it is probable that natural causes would result in the death of many individuals early in their career, and the same is true in the breeding jars, though deaths in the latter are usually the result of confinement and unnatural conditions. One to a certain extent offsets the other, and the above records may be considered as giving a fair idea of what actually occurs in the field.

Our observations on eggs laid in breeding jars showed that they are deposited in masses of from 1 to 125, the latter being the largest number observed in one cluster. A normal egg mass measures about $\frac{1}{5}$ inch in length and less than one half that in breadth. The somewhat concentric arrangement of the eggs is shown on plate 1, figure 3. The rows of eggs often overlap each other like shingles, and in the center of the mass there is frequently an appearance of two or three layers. The egg clusters are sometimes deposited so that two thirds of the branch is encircled, and in each case the whole mass is covered with a sticky substance, which glues each egg to the other in

such a manner that the whole may be easily detached from the vine, as is often the case when a strong wind is blowing.

The duration of the egg stage was determined by repeated observations both last year and this as from 9 to 12 days, about one day being required for an entire mass of eggs to develop after hatching commenced. We were also able to verify Professor Webster's observation on the appearance of a narrow semitransparent band or line near each end of the egg four days after oviposition. Small numbers of empty egg shells, indicating that hatching had begun, were found in Mr G. L. Hough's vineyard July 24, 1902; and it is very probable that in Mr Clyde Dean's vineyard at Portland, where conditions are about a week earlier, young grubs had appeared some time before.

Habits of the grubs or larvae. The young larvae, after they hatch from the eggs, drop to the ground, as observed by Professor Webster and corroborated in our own experience. There seems to be very little or no attempt on the part of these tiny creatures to crawl down the stalk. A recently hatched grub is such a small creature that it rapidly makes its way into any crevice or crack, and when it drops on loose earth soon disappears from sight. Earlier writers have recommended the covering of the roots of grapevines as deeply as practicable at the time the young hatch, so as to present more obstacles to the grubs when making their way to the roots. This suggested to the writer some experiments to determine the burrowing and traveling powers of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during that entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial, and under such unfavorable conditions lived about three days. This would seem to indicate that the little creatures can make their way over many obstacles if not confronted by very unfavorable conditions.

Some tests were also planned to ascertain the burrowing powers of these little grubs. A glass tube 17 inches long and ½ inch in diameter was bent so that 4 inches were vertical. It was then filled with loosely packed earth, and on July 29, 40

recently hatched grubs were placed on the surface of the soil in the 4 inch vertical portion. One grub had made its way through the entire mass of soil by July 31, another by Aug. 1, and 11 others by the 3d, making a total of 13 which had traveled the whole length of this tube in a period of four days.

Another ½ inch tube, 10 inches long with 3½ inches vertical and 6½ inches of its length horizontal was similarly packed and 13 grubs placed on the surface of the soil July 29. Four of these had made their way throughout the entire length of the tube by Aug. 3. Another tube 12 inches long, ½ inch in diameter, with 2½ inches of its length vertical and the remainder horizontal was filled with tightly packed soil and a number of grubs placed in it Aug. 1. On the 7th one grub had made its way through 7½ inches of this tightly packed material. It would seem from the above experiments that, while a great many grubs undoubtedly perish in making their way from the vine to the succulent roots on which they feed, they are capable of overcoming great obstacles, and the facts ascertained above at least raise a question as to the advisability of attempting to interpose barriers between the grub and the roots on which it feeds.

The young larvae or grubs are undoubtedly able to exist for some time without food. They soon make their way when possible to the young feeding roots, where they may sometimes be found in considerable numbers. The writer, in the middle of August 1902, succeeded in finding eight of these little creatures under a small bunch of feeding roots. They were less than one quarter grown, and under larger roots near them several others were found which were about half grown. Aug. 18, 1903, quarter and nearly full grown grubs were found in some Westfield vineyards. The occurrence of few half grown larvae and of considerable numbers of nearly full grown individuals the middle of September 1902 indicates that these creatures develop very rapidly after they have found suitable roots on which to feed. The finding of a small grub scarcely $\frac{1}{16}$ inch long July 2 shows that some do not attain their full growth in the fall, since this individual could not have hatched from an egg laid in 1902, as the beetles had hardly begun to appear, and that such individuals must feed to some extent in the spring. It seems probable that these very small grubs produce the later emerging beetles and are

therefore responsible to a limited degree for the very extended period during which adults are found abroad. Most of the grubs complete or nearly complete their growth in the early fall, and on the approach of cold weather descend deeper in the earth. Professor Webster records finding the grubs a foot below the surface in the spring, and our own observations indicate that they descend nearly to that depth, where they pass the winter in small oval cells. Their ascent in the spring occurs after the appearance of warm weather and probably some time in early May. Experiments in 1903 with grubs collected the latter part of April demonstrated the ability of full grown and apparently half grown larvae to complete their transformations with no more nourishment than is found in ordinary garden soil in which there are no grape roots. Those about quarter grown were not able to survive the test. On the other hand, some nearly full grown individuals were observed last spring feeding on the roots to a slight extent in our breeding cage.

Pupa. Professor Webster records the finding of a very few pupae as early as the first week in June, and Mr Barden states that in 1902 he observed the first pupae at Ripley June 7, though Mr Hough is of the opinion that the larvae began to transform as early as June 4. The great majority of the insects had transformed to this stage by June 23. The present season was considerably more advanced than that of last year, and 90% of the insects were in the pupal stage May 29, 1903, on light sandy loam. The cells are almost entirely within 2 or 3 inches of the surface and usually within 2 or 3 feet of the base of the vine.

The duration of the pupa stage has been stated by earlier writers as about a fortnight and actual observations with breeding cage material have enabled us to determine this period as from 13 to 14 days. These observations were made in the office, where temperature conditions were uniform and rather high, and it would not be surprising if this period was materially extended out of doors in unusually cool weather.

The oval cells occupied by the larvae can be broken repeatedly, and the grubs will make others, but such is not true of the pupae. The insects are so delicate in the latter stage that the writer has experienced great difficulty in transmitting them through the mails, even with most careful packing. This is shown by the fact that out of 58 mailed to Albany only 15 arrived alive; a number

were carefully packed in their cells or laid on moist cotton, otherwise the fatalities would have been much higher. Cage experiments in the field show that from 50% to 75% or even a larger proportion may be destroyed by timely cultivation [*see* p. 27]. These facts have a very important bearing on remedial measures, as will be pointed out under that head.

EXPERIMENTAL WORK IN 1903

This is a very convenient heading under which to group a number of records of work carried on under similar conditions, yielding data which can be readily tabulated and which should be discussed under various headings. This work was conducted in the vineyard of Mr D. K. Falvay of Westfield, who contributed not a little to its success.

Eight large, thrifty Concord vines of as nearly uniform size and conditions as could be determined by examination were carefully covered by wire cages [pl. 7, 8] so arranged that no insects such as Fidia could escape, nor could any enter from outside. The cages were numbered respectively from one to five, running from east to west. Numbers 1, 2 and 5 contained two vines each and numbers 3 and 4 but a single vine. Number 1 was a check cage, which was watched carefully for the purpose of comparing with conditions obtaining in other cages. Number 2 included two Concord vines around which the soil had been carefully hoed at the time the majority of the insects were in the pupal stage. The work was not more thorough than could have been done by a horse and cultivator. The vine in number 3 was sprayed with arsenate of lead, 1 pound to 50 gallons of water. The first application was made June 19 and the second June 27. The work was done by Mr Barden, who used a small hand atomizer and took special pains in each instance to cover every portion of the foliage so far as was possible. The vine in number 4 was sprayed with a poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and $\frac{1}{4}$ pound of paris green being used to 40 gallons of water. The spraying was done by the same person and in the same manner as in the case of cage 3. The vines in number 5 were reserved for the purpose of determining exactly when the beetles appear above ground, and it was visited at intervals of a few days to a week or thereabout and the beetles removed till practically all had emerged. The tabulated record is as follows:

Record of cage experiments 1903

DATE	1 Check	2 Cultivation	3 Arsenate lead 4 lb to 50 gal.	4 Poisoned bordeaux mixture	5 Beetles collected
June 5		Carefully hoed to depth of 3 in.			
19			Sprayed thoroughly	Sprayed thoroughly	
22	8 beetles	2 beetles	24 beetles	18 beetles	22 beetles
24	19 beetles	7 beetles, practically no feeding	36 beetles, some feeding	32 beetles, some feeding	75 beetles
25					50 beetles, 6 p. m.
26	41 beetles	10 beetles, much recent feeding	56 beetles, more feeding	56 beetles, more feeding	50 beetles, 11 a. m.
27			Sprayed second time	Sprayed second time	
28					31 beetles
30					123 beetles
July 1	141 beetles, considerable feeding	45 beetles	72 beetles, 1 recently dead, considerable feeding	90 beetles, 5 wing cases (representing 3 beetles), 1 hanging dead	41 beetles
2					33 beetles
6			None dead	None dead	57 beetles
7					6 beetles
14			None dead, few living, 3 egg clusters	None dead, few living, 5 egg clusters	8 beetles
21	Fewer beetles than in 2, 3 or 4 and fewer eggs than in 3 or 4	Beetles more numerous than in 3 or 4, less feeding than in 1, 3 or 4	6 egg clusters and more beetles and more feeding than in 4	Very few beetles, 6 small and 5 fair sized egg clusters	13 beetles
Aug. 1	7 beetles	1 beetle	None	None	2 beetles
18	None	None	None	None	No beetles. Total 511

It will be seen, on comparison between the cage in which cultivation occurred and the number of beetles observed in cages 1, 3, 4 and 5, that a large proportion of the insects must have been destroyed by this means. In all probability over 50% and possibly 75% or even more, were killed by cultivation, because we find that on July 1 there were 141 beetles in cage 1, and in cages 3 and 4, which should be added together as each contains but a vine, there were 162, while in cage 5 we had obtained at that time nearly 400 insects. In cages 3 and 4, it will be observed that there were 72 and 90 beetles respectively living July 1, 12 days after the first application of poison. One dead insect was found in cage 3 and five wing cases, representing three individuals, and another hanging in cage 4. The conditions, however, in these two cages, as compared with the others at the same time, were so similar that we could not be certain that the relatively few insects found dead had been killed by poison, and the same was true on July 6, 14 and subsequent dates. A study of the record of captures in cage 5 showed that a very large proportion, 92%, of the beetles appeared above ground within two weeks after the first insects were observed abroad. In other words, we bred from the soil about two vines 511 beetles, 477 appearing in the first two weeks.

The experimental vineyard,[1] which was selected only after extensive examinations in different vineyards in the Chautauqua grape belt, appeared to be a place where the insects were rather abundant and yet had not caused very serious injury unless it was in the immediate vicinity of the cages. The plot selected

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[1] The cultivation of this vineyard is of interest, and data relating thereto, kindly placed at my disposal by Mr Falvay, is as follows: Ap. 28 the vineyard was gang-plowed, and was horse-hoed the 30th; May 4 it was hoed by hand; May 7 harrowed with a spring-tooth harrow; May 11, 350 pounds of kainit to an acre applied; May 14,* one furrow on each side of the row was turned toward the vines; May 22, the space between the furrows was cultivated; June 5,* horse-hoed for Fidia, following with the cultivator; June 16, cultivated for Fidia. Each process required about a day, and the cost for 5 acres was placed at $27. The additional cultivation (*) for Fidia amounted to $8.50. The vineyard since Aug. 1, in addition to that given above, has been gang-plowed, harrowed with a spring-tooth harrow and cultivated, each operation twice in a row and one after the other, and followed by cultivation with an acme harrow. The vineyard is showing the effects of good treatment and has developed a very satisfactory amount of wood in spite of previous root worm injury.

was the portion just south of Mr Falvay's packing house, extending over a gravelly knoll into a loamy hollow. The region next to the packing house contained comparatively few insects, which was probably due in considerable measure to a neighbor's chickens working in that section. The first 24 rows south of the packing house were reserved largely for demonstrating the effectiveness of collecting, and no cultivation for the destruction of pupae was allowed on its six southern rows and also on the next six rows of the adjacent plot. The next plot of 13 rows was sprayed with arsenate of lead, 5 pounds to 50 gallons of water. The application was made July 26 and special pains were taken to cover the vines as thoroughly as possible. The 11 rows south of the arsenate of lead plot were sprayed the same day and in the same manner with poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and $\frac{1}{4}$ pound of paris green being used to 40 gallons of water. The next two rows were not sprayed, but were left as checks, and the following 11, namely those just north of the cage except one, were sprayed with an arsenate of lead mixture as described above. The spraying with poisoned bordeaux was thorough, though not quite so carefully done as in the case of the arsenate of lead. At the time the application was made there was a considerable evidence of feeding in the section next the cages and also in that sprayed with the poisoned bordeaux mixture. The row just north of the cage and that on which the cages stood received no poison.

Insects taken by the beetle catcher. The operation of the beetle catcher over 5 acres resulted not only in capturing a large number of Fidias but also in taking a number of other species. The list is of interest because it indicates in a measure the excellent cultivation and care which this vineyard has received. It will be observed that no species appeared in any numbers compared with those of Fidia, which fact alone is of considerable value in indicating the care and clean culture given the vineyard. A few caterpillars and other soft bodied larvae were taken but in relatively no larger numbers, and no attempt was made to count them. The list follows, and it will be seen that the number taken of any species is so small that practically all may be neglected, as regards either beneficial or injurious powers.

NUMBER OF VARIOUS INSECTS TAKEN IN BEETLE CATCHER

COLEOPTERA

1 Calathus gregarius *Say*, July 7, 14, 26
1 Bradycellus rupestris *Say*, June 26
2 Megilla maculata *DeG.*, spotted lady bug, July 7
1 Coccinella 9-notata *Hbst.*, nine spotted lady bug, June 26, July 7
1 Chilocorus bivulnerus *Muls.*, twice stabbed lady bug, June 26
10 Brachyacantha ursina *Fabr.*, June 26, July 7
2 Tenebrioides corticalis *Melsh.*, June 26
1 Melanotus communis *Gyll.*, June 26
2 Asa hes baridius *Say*, June 26
2 Pyropyga nigricans *Say*, June 26, July 7
1 Telephorus carolinus *Fab.*, June 26
1 Hydnocera *sp.*, June 26
1 Macrodactylus subspinosus *Fab.*, rose beetle, June 26
1 Pelidnota punctata *Linn.*, spotted grapevine beetle, July 1, 14
1 Xylotrechus colonus *Fab.*, July 1
1 Euderces picipes *Fab.*, July 14
1 Eupogonius tomentosus *Hald.*, June 26
1 Doryphora 10-lineata *Say*, July 14
1 Disonycha xanthomelaena *Dalm.*, June 26
6 Haltica chalybea *Ill.*, steely flea beetle, June 26, July 14
1 Crepidodera helxines *Linn.*, June 26
1 Doryphora clivicollis *Kirby*, June 26
4 Systena taeniata *Say*, pale striped flea beetle, June 26
1 Notoxus monodon *Fab.*, June 26
20 Otiorhynchus ovatus *Linn.*, ovate snout beetle, June 26
1 Phytonomus punctatus *Fab.*, punctured clover leaf weevil, July 1
1 Conotrachelus nenuphar *Hbst.*, plum curculio, June 26
1 Hylobius pales *Hbst.*, Pales weevil, July 7

HEMIPTERA

1 Canthophorus cinctus Beauv., July 14
1 Euschistus tristigmus *Say*, July 1
1 Nezara hilaris *Say*, July 1, 7
8 Lygus pratensis *Linn.*, tarnished plant bug, July 14
1 Thamnotettix clitellaria *Say*, June 26

Observations showed that the red-headed flea beetle, Systena frontalis Fab., was somewhat abundant in Sheridan vineyards July 21 and relatively much more so than in and about Westfield, where most of our experimental work was done.

Food plants. This beetle has a comparatively restricted food habit. It was early observed by Mr Walsh on grapevines, and the late Professor Riley recorded its feeding on the American redbud, Cercis canadensis. It is also known to feed on the native Virginia creeper, Ampelopsis quinquefolia.

Varieties affected. The Concord, as is well known, is almost universally grown in the Chautauqua region, and consequently is one that has suffered to the greatest extent from injuries by this pest, though our observations convince us that the Niagara is even more liable to injury, and in the cases we have seen the difference was quite marked. Referring to Ohio reports, it will be seen that Mr Maxwell states that Wordens and Brightons were killed first, while Concords and Catawbas were not so badly in-

jured, and in a later report he states that renewing a vineyard with Niagara vines seems to be quite a success. This latter point, we think, needs further demonstration. On the other hand it will be observed that Mr Slade considers that the Wordens and Catawbas suffer more than the Concords. The relative liability of different varieties to injury is probably influenced to a considerable extent by location and character of the soil, specially the latter, and it is therefore not surprising to meet with some discrepancies as to the relative amount of injury they suffer. Extended observations and probably careful experiments are necessary before authoritative conclusions can be reached.

GRAPEBERRY MOTH
(Polychrosis botrana Schiff.)

This species is present in more or less numbers in most vineyards, and as it was met with in the course of our experimental work on Fidia, and since this latter gave some valuable results on methods of controlling this fruit pest, a brief notice of it is included. This species is specially destructive in the vicinity of forests or in vineyards near which bushes of various kinds, particularly sumac, are allowed to grow. It is believed to have two generations in this country, the larvae of the first feeding on the blossoms and those of the second in the fruit. There is possibly a third brood. It is gratifying to state that we have obtained excellent results in controlling this pest with arsenate of lead and also the poisoned Bordeaux mixture. The spraying, done shortly after blossoming and while the fruit was not larger than a small pea, was primarily for the purpose of killing Fidias; but investigation this fall shows that it was much more effective in destroying young of the grapeberry moth, since there is certainly 50% less damage to fruit on sprayed than on unsprayed rows, even when the two are side by side. The difference was so marked that it was easily observed, and in walking between the treated and untreated areas, it was not hard to find infested clusters on the one side while on the other they were much less abundant. It was also observed that not only was this insect checked by spraying but the foliage was benefited by the treatment, having a better color and remaining on the vines a longer time.

Our experiments were in Mr D. K. Falvay's vineyard, and he informs us that last year a section of six or seven rows in his

vineyard next to a lot of sumac and other bushes, was so badly infested by this worm, that no attempt was made to pick it. The wild growth was cut away last winter and burned, and the fruit on these rows was no more infested this year than that of any other section of the vineyard.

We therefore advise clean culture, specially the destruction of bordering hedges and adjacent miscellaneous forest growths and the burning of debris in a vineyard, in order to lessen shelters where the insect may pass the winter. It is advisable to locate vineyards when possible at some distance from woods, and where-ever they are infested to any extent by this pest, spray with an arsenical at least once after blossoming.

NATURAL ENEMIES

This serious grapevine pest is subject to attack by several natural enemies. Two interesting species of egg parasites, bearing the scientific names Fidiobia flavipes Ashm. and Brachysticha fidiae Ashm., were bred from eggs of this insect by Professor Webster in 1894, and in 1896 he expressed the belief that a marked decrease in numbers of the Fidia was possibly due to the work of these parasites. Professor Webster also observed a small brown ant, Lasius brunneus var. alienus, feeding on the eggs, and a small mite, provisionally identified for Professor Webster by Dr George Marx, as Tyroglyphus phylloxerae P. & R., extracting the contents of several eggs in succession, and also a smaller mite resembling Hoplophora arctata Riley. Another mite, Heteropus ventricosus Newport, was met with by Professor Webster in 1896 who credits it with being quite destructive to the eggs of this pest. One of these small mites, probably a species of Tyroglyphus, was observed in our breeding cages feeding on the pupae, one being almost entirely destroyed.

Several predaceous insects were found by us during field work, specially when digging for larvae in the early spring. The grubs of some carabid beetle were observed to be about two thirds as numerous as those of Fidia during the last of April, and it is very probable that they prey on this species. We were unable to bring any of the carabids to maturity. A small beetle, Staphylinus vulpinus Nordm., was associated

with Fidia grubs and possibly preys on them. The larva of an aphis lion, Chrysopa species, was observed by the writer investigating under loose bark where eggs were present, and it is not at all improbable that these insects destroy many.

REMEDIAL MEASURES

It was felt when this study was undertaken that there was a lack of definite knowledge regarding methods of controlling this insect and it was accordingly planned to make a thorough test of those advised as well as to experiment in other directions. Some of these investigations gave results which appear to have a positive value, while others only proved certain measures comparatively useless.

Destroying the pupae. There is no doubt as to the benefits of cultivating vineyards for the purpose of destroying the pupae, if the operations are properly carried out. In the first place, plan to have a moderately high ridge of firm earth about the base of the vines the latter part of May, so that the grubs will come well above the roots before transforming to the pupal or "turtle" stage. Then adjust operations so that horse-hoeing away from the vines will come early in June, thus avoiding special cultivation for the purpose of destroying the insects. It may be found, however, that some adjustment of the cultivator, so that it will work a little deeper, or a little extra care in keeping the implement close to the vine, will materially increase the efficiency of this operation. In 1902 our attention was called in the early part of June to a vineyard where there were from 50 to 60 grubs about many of the vines, while repeated search the latter part of the same month failed to discover more than three or four pupae under a vine and in many cases not a specimen. In the interval this vineyard had been carefully cultivated for the purpose of destroying the pupae, and we are of the opinion that this practice was largely responsible for the scarcity of the insects. This is further substantiated by our cage experiments in 1903 [*see* p. 27] which show that from 50% to 75% or more of the pupae can be killed by cultivation no more thorough than that given by horse implements. These data lead us to believe that much can be accomplished by planning cultural operations so that the vineyard will be horse-hoed at the time when the majority of the insects

are in the pupal or "turtle" stage. This operation may well be deferred till some of the more advanced insects begin to brown a little or even till a very few have changed to beetles, and its efficiency can be further enhanced by repeating the cultivation, with a spring-toothed harrow, about a week or 10 days after in order to catch some of the later transforming individuals. There may be a difference of a week or more in the development of the insects in a vineyard, and this means that each grower should know the pupa and watch for its appearance. This variation is due largely to the character of the soils, as some warm up much more rapidly than others, and the final changes to beetles occur correspondingly quick.

Collecting beetles. This method of controlling the grapevine root worm did not promise much when it was first attempted. Professor Webster had either not considered it worth trying or had found it of comparatively little value, and Dr Marlatt did not even mention it in his recommendations. Professor Slingerland made the guarded statement in 1902 that it may be practicable in some cases to jar the beetles into a collecting apparatus, but he apparently had little faith in the plan, except when the insects could be jarred to the ground where they would be eaten by chickens.

Mr J. J. Barden, working under the writer's directions in 1902, found that, even with a plain cloth-covered frame several feet square and with a small slit in one side, so that it could be slipped under a vine, large numbers of the insects could be collected. With this crude apparatus he was able to capture a quart of beetles in about two hours. This indicated that much better results could be secured with a more elaborate apparatus; and with the aid of Mr G. L. Hough he constructed a modified form of the Curculio catcher, which is represented on plate 9. The machine is 6 feet long and 3 feet wide at the top, with vertical ends and the sides sloping to a trough about 3x3x72 inches. A central slit about 3 inches wide was cut in the side opposite the handles and the whole mounted on a two wheeled frame. The long trough is subdivided by a few transverse partitions, and these spaces are partly filled with kerosene and water. The sides, ends and trough are constructed of galvanized iron and strengthened with iron straps as shown in the figure. The

wheels are from a toy cart and the handles and frame are home-made. The method of operation is simply to wheel the machine between the rows, and then, elevating the handles, to slip the farther side under the wire, and the trunk of the vine entering the slit permits the placing of the machine directly under the vine. It then remains for the operator to jar the insects off. Mr Barden found that it required several shakings to dislodge all the beetles. In one case he succeeded in catching 64 by jarring a vine once. It was found advantageous to have three machines operating together and placed simultaneously under adjacent vines. This arrangement facilitated the work very greatly and reduced to a minimum the beetles jarred from vines before a machine could be placed under them.

This method appealed so strongly to Mr Hough, who by the way is a very practical business man, that he used it daily for a time on certain badly infested vines, and found that, in the case of the third jarring, he did not get over three or four beetles to a vine, whereas at the first operation 40 to 50 were secured and 15 or 20 at the second jarring. An examination in this vineyard July 24 showed that the beetles were not nearly so abundant as two weeks before, largely due to four collectings in two weeks. The Hough beetle catcher was further tested in 1903, with the result that 1343 beetles were taken June 26 from approximately 110 vines, or an average of over 12 to a vine. The principal difficulty with this device is the relatively large amount of time consumed in placing it under a vine and making the necessary jarrings.

Collecting beetles, if rapidly done, appeared to be a feasible method of checking this pest and our plans contemplated a rigid test of its possibilities in 1903. Mr F. A. Morehouse of Ripley designed an improved form of catcher, the essential idea of which is continual motion and jarring. We arranged to have one built and thoroughly tested, believing the situation justified the experiment, and the results have been most gratifying. This machine, illustrated on plates 10, 11, 12, is essentially a pair of troughs on wheels and is drawn through the vineyard astride the row. The troughs are connected over the vine by bracing arms and wires (placed high enough to clear all posts) and are hung by ½ inch iron rods, which permit the side

springs to push the troughs under the vines so that their inner edges are close to the stems or posts as the case may be. The outer slope of each trough is a 3 foot strip of oilcloth stretched over a frame, while the inner is a 10 inch rubber belt 11 feet long. These sloping sides guide the insects so that they fall into the eaves trough, which is divided into small sections by a number of water-tight compartments each of which contains a quantity of water with a small amount of kerosene floating on its surface. The whole machine, as will be seen by the illustrations, is a home-made affair, and was built simply to test the practicability of the idea. The dimensions are as follows: length 12 feet, width 5 feet, hight 7½ feet, length of trough 11 feet, of runners for same 12 feet, diameter of wheels 2½ feet. It can undoubtedly be made considerably more efficient; the troughs, for example, should be broader in order to accommodate more insects and debris. The common wooden springs could be replaced by steel ones and the rough wooden wheels by well made wooden or iron ones, and, instead of being on a fixed axle, it would be a decided advantage if they were on a swivel axle. All these improvements can be easily made later in case the machine commends itself to growers. This device was drawn over two rows of approximately 120 vines and took therefrom 1583 beetles, or an average of about 13 to a vine. This was at a time when not over 17 could be counted on a vine, though there were probably more. The entire operation consumed less than 20 minutes, and, somewhat to our surprise, the efficiency of the machine appears to be a little higher than that of the Hough beetle catcher. It was also operated over nine other rows and 3300 beetles secured, an average of about six to a vine. These rows were not quite so badly infested as the two mentioned above. The record of collecting with this machine, in addition to that above, is of interest and is given herewith.

July 2, 2650 beetles were taken from two check rows, which were in reality but one and one half rows, owing to many of the vines being very small and some missing. June 30 and July 1, 72,000 beetles were captured with this machine from all the experimental plots. July 7, 34,550 and July 14, 8380. Comparing the last three catchings, which were all from the entire area, it will be seen that there is a decrease of over 50% between the catch of July 1 and 7 and that the catch of the 14th was less

than 25% of the catch on the 7th. About 154,900 beetles were taken from this area of approximately 5 acres, 3 of which were much less infested than the 2 next the experimental cages. This means that an average of 59 beetles was secured from each vine in spite of the fact that a considerable proportion of the area had been previously cultivated for the special purpose of destroying the pupae. These figures give some idea of the immense number of insects which must have been in the vineyard when work was begun last spring.

As further evidence of the value of collecting for this insect, it may be interesting to state that last spring, sample diggings under different vines in the experimental area, gave from 8 to 50 or more grubs or as calculated from 60 to 400 or more to a vine, in one case it was estimated that there were fully 1000 under a single vine. Sample diggings in October resulted in obtaining no grubs from three vines, one only from each of three, and two only from two others, indicating that there were very few which had more than 12 or 15 grubs, and that, in all probability, the number to each vine would hardly exceed eight or nine. In other words, cultivating and collecting in one season reduced the number of grubs about 98%. These figures are sufficiently striking, so that no further comment is necessary on the efficiency of collecting and destroying the beetles; in fact, this vineyard after one season's work may be considered more free from the pest than almost any other in that section, and it will compare very favorably with those in places where Fidia has caused practically no injury.

Our experience with collectors has demonstrated the practicability of catching the beetles, and we recommend this operation for all badly infested sections, and that the collecting be begun as soon as the beetles appear on the vines in any number, say, when there are 12 or 15 on one. The operation should then be repeated at intervals of five to seven days till the vines have been gone over two, three and possibly four times, dependent somewhat on the number of insects which are captured. It will be found that it is much easier to catch the beetles on warm days, when it should be done, than in cool weather.

It may be added that the efficacy of a machine of this character could be materially increased by the adoption of various devices which would tend to lessen the open spaces under the vines and to increase the length of the catching surface. It is interesting in this connection to note that vineyardists in Missouri have been resorting to various catching devices for the protection of their vines from this pest. Many of them employ simple sheets and jar the beetles on them, while others are using a wheelbarrow arrangement on the suggestion of Professor Stedman.

Mr R. S. Blowers, of Portland, after examining the work of our beetle catcher at Westfield, constructed a very effective and cheap device [pl. 13], which is at least worthy of illustration and comment in this connection.

Its essential features are two long frame troughs covered with oilcloth, which hangs over an eaves trough divided into watertight compartments, as in the ordinary catcher. These two sections are each 24 feet long, the outer edge about 3 feet high, while the inner edge is approximately 18 inches high, and each is braced so that a man can pick it up at the center and move it toward or away from the vines. The original plan was to carry it through the vineyard and place it between the posts, jarring the vines and continuing in this manner. This was found rather laborious, and the work was made lighter by the construction of a pair of low bobsleds, fastened together by wires so that each was about 6 feet from the end of the trough, which at this point was provided with a transverse broad base so that it would rest on the bob without tipping. The inner edge of each bob was also provided with a small roll, so that the operator, by tipping the trough slightly toward the row, could roll the entire structure under the vines and, after jarring was completed, could roll it back. A horse was used to draw each half of the collector, and in this way about 3 acres a day could be gone over. This collector has the advantage of being comparatively cheap, since the outside expense for it would not exceed $9 for each half, or a total of $18. Most of the material, except the oilcloth, can usually be found around a farm, and the actual outlay, if the vineyardist made it himself, would be very little.

The late Prof. C. V. Riley, in his report for 1868, calls attention to the fact that one man whose vineyards were very badly infested by this insect had trained his chickens to go between the vines and pick up the beetles as they were dislodged by jarring. Mr. F. A. Morehouse of Ripley, who has many chickens in the near vicinity of his vineyard, has practised the same thing with excellent results. The only trouble is that this method has a comparatively limited application, since it is not always practical to have chickens in large vineyards.

Arsenical poisons. A number of experiments were tried with arsenical poisons in 1902 for the purpose of ascertaining their efficiency in controlling this species. Two brands of arsenate of lead and paris green were used. Breeding cage experiments with arsenate of lead, using 2 pounds to 50 gallons of water, showed that seven days were required to kill 9 out of 10 beetles, and that, when 4 pounds of the poison were used to the same amount of water, all of the insects were killed within eight days. The spraying in both instances occurred July 5, and the record is as follows:

2 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 6 beetles dead	July 10, another beetle dead
3 alive	July 11 "
1 missing	July 12 "

4 POUNDS ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 4 beetles dead	July 10, another dead
July 9, 4 more dead	July 13 "

It will be seen by examining the above records that in the case of the first over half were killed within 48 hours after the spraying, and in the second less than half within 48 hours and four fifths within four days. It should be added that in the above experiments the leaves were sprayed very thoroughly and the poison allowed to dry before the treated foliage was placed in the cage.

The breeding cage experiments with paris green were less successful than those with arsenate of lead, and, though in one experiment 20% of the beetles were killed within 48 hours after

spraying the leaves with 1 pound of the poison and 1 pound of lime to 100 gallons of water, and 40% more died within four days after the spraying, the general results were not at all satisfactory, and the reason therefor can not be given.

The breeding cage experiments with arsenate of lead would lead one to expect most excellent results in the field, but such was not the case last year, though this may have been due to the fact that the spraying was done shortly before considerable rain fell, and was followed by nearly daily precipitations. The initial application was made July 8, 1902, and repeated the 9th, the rain of the preceding day making it advisable to go over the entire field a second time. The ground at the time the spraying was done was so wet that it was almost impossible to drive a team slowly enough to do good work. Careful search in the vineyard eight days after failed to reveal a single dead beetle. July 31 there were plenty of beetles and many eggs in Mr Northrop's vineyard, where the vines had been sprayed. The necessity of two sprayings resulted in the application of considerable poison, and about five weeks after the treatment it was seen that the sprayed vines had developed very little new growth as compared with untreated ones. There was no perceptible burning, yet the edges of the leaves were somewhat crumpled, and it is very probable that the poison checked the development of the more tender shoots.

The breeding cage experiments in 1902 led us to expect excellent results in the field, and our not obtaining the same after making two applications was attributed largely to the excessively wet weather, which not only washed off the poison but interfered with work in the vineyard. Similar experiments in 1903 gave even less satisfactory results than the year before. It required nine days to kill three out of five beetles. Arsenate of lead and poisoned bordeaux mixture were severely tested in caged outdoor vines, as detailed on page 26, 27. It will be seen by consulting the record that, though the vines were sprayed thoroughly on both June 19 and 27, there were fully as many living beetles on both July 1, 13 days after the first application, as on the two vines in the check cage, and the same was true July 21. Careful observation, during the remainder of the

period when beetles were to be found in cages, failed to disclose any substantial difference between the insects on the poisoned vines and those on the untreated ones. These cage experiments were further supplemented, as detailed on page 29, by extensive spraying. This was done June 25, and July 1 no difference could be detected between the sprayed and the unsprayed vines. This, in connection with our cage experiments, led us to abandon reluctantly further outdoor tests, and the poisoned areas were collected over in order to prevent what we deemed would be an extensive deposition of eggs. In other words, no experiments, other than those confined to small tumblers where the beetles could obtain absolutely nothing except poisoned foliage, gave results which are at all decisive. The reasons for this are several: the beetles do not succumb readily to poison, and being more or less secretive by nature, feed to a considerable extent on under leaves and in concealed situations where it is difficult to throw the spray. In addition they have a marked tendency to feed on the more tender leaves, which at the time spraying should be done appear almost daily on vigorous vines. These factors make it very difficult to control the insect.

The most decisive results obtained with an arsenical spray are those published by Mr John W. Spencer of Westfield, in the issue of the *Grape Belt* for July 24, 1903, in which he gives some definite figures in favor of spraying. Our only regret in this connection is that his experiments were not conducted on rapidly growing vines, because in our judgment these need protection much more than those in poor condition and on which the insects, as previously pointed out, can not be controlled nearly so readily.

Several vineyardists sprayed their vines in 1903 for the purpose of controlling this insect, and as it was stated by various growers that the poison applications had been successful, at their request these vineyards were inspected by us the first week in October, and much to our regret, we found that the reported good results were more apparent than real.

An examination in the vineyard of Mr Frank Monfort, of Brocton, resulted in finding 5, 45, 10 and 9 grubs respectively under as many Concord vines. The first record relates to a

vine which had very poorly developed roots, and consequently was not a fair sample of conditions in the vineyard. Mr Monfort not only sprayed his vineyard twice with a power sprayer, making the first application at the time the beetles appeared and the second a week later, but went to the additional trouble of going over the entire area carefully with a hand pump for the purpose of spraying any which the machine might have missed. He certainly tried to do a thorough job, and yet sample diggings in an adjacent vineyard belonging to Mr Morse gave respectively 3, 6, 3, 6, 16 and 9 grubs under different vines. The two latter records could hardly be compared with those in Mr Monfort's vineyard because they were fully ¼ mile distant and relate to vines which were much more healthy and vigorous. It may be claimed that this is not a fair test of the poison and to a certain extent this is true, yet these are results obtained by a practical man in an earnest effort to reduce the pest, and as they agree with our own experience are not without value. The difference between 75 and 150 grubs under a vine, and 5 to 12 or thereabouts, represents in our mind the relative efficiency of collecting and poison sprays, and our judgment is that these figures mark the difference between protection and serious injury.

The evidence concerning the efficacy of poisons in Ohio, as pointed out on a preceding page, is somewhat contradictory. Reporting on work done in 1899 Professor Webster states that an examination of sprayed fields showed nothing to indicate that arsenate of lead would not prove entirely effective. This differs from some later experiments performed under his direction by Messrs Newell and Burgess, the unpublished records of which through the kindness of Prof. P. J. Parrott have been placed at my disposal. The summary of this later work is as follows:

"Where beetles were abundant last year and vines seemingly badly injured and the arsenate of lead or disparene used this year (1900) few vines have died and all appear in a more healthy condition, but this is true also where none of these insecticides were used, beetles appearing later and in less numbers than for several years." Professor Webster, at the writer's request, has commented on the above experiments as follows. He states that

early results, though satisfactory, were not thought by him to be conclusive, and that a marked decrease in the number of the beetles vitiated later experiments to some extent, so that he did not consider them as either conclusive in themselves or as disproving the earlier work of Mr Mally. He states that arsenate of lead must be tried thoroughly several times where conditions are such as to enable one to obtain decisive results either one way or the other before it will be safe to make definite statements. Professor Stinson reports only fair success in destroying the beetles with poisons in Arkansas.

It seems very probable, therefore, that some of the Ohio growers have been led to attribute the relative scarcity of these beetles to the use of poison whereas it may have been due almost entirely to natural conditions.

Mr T. S. Clymonts states that in his experience spraying with bordeaux mixture has proved of some benefit, since the beetles prefer untreated vines and will migrate to them if near by.

Mr J. W. Maxwell, Euclid O., writing under date of Aug. 29, 1903, states that he called Prof. F. M. Webster's attention to the insect in 1893 and adds that in all his experience, now extending over a decade, he has not found a poison that will "exterminate" the insects, or, in other words, that has given satisfactory results.

Prof. F. M. Webster has recently called our attention to a case in Bloomington Ill., where the owner of a badly infested vineyard, began spraying thoroughly with arsenate of lead. He says that the vineyard at the outset was in very poor shape, that now it is returning to somewhere near its normal condition, and that he fails to find the slightest indication of beetles except on one or two vines. This has been accomplished within two or three years; and the owner, Mr J. L. Lampe, attributes it to the use of the insecticide, with which Professor Webster is inclined to coincide. Our experience with the pest suggests that possibly many of the insects may have forsaken this vineyard because of its poor foliage and gone to others where there was better shelter, and that therefore the protection afforded by the arsenate of lead may have been overestimated. In a later communication, Professor Webster states that he has found great numbers of dead beetles under sprayed vines and none under those

free from poison, a fact that shows that some protection is afforded. This, however, was in a vineyard which had been seriously injured and was therefore not making much growth.

We have been to considerable pains in looking up evidence both for and against arsenical poisons and the above summary of results obtained in Ohio, in connection with the work done in New York and elsewhere, leads us to the conclusion that, while the arsenical spray may, under certain conditions, give some protection from this insect, either by driving away the beetles or possibly killing them, we are by no means certain that this will result, specially in the case of more thrifty vineyards, and we are inclined to believe that in some instances the benefits resulting from poison applications have been greatly overestimated. We do know, on the other hand, that collecting and killing the insects, if it be done early enough, means protection, and for the present we prefer to recommend the latter method of fighting the pest rather than to indorse the use of a poison, the general utility of which has not been proved for Fidia. Enough has been done to warrant more extended work with poisons and it may be that another year or two will enable us to determine their true value.

Destruction of the eggs. This seemingly difficult operation was accomplished by Mr William Barden of Ripley by rubbing the canes with a gloved hand. He found that most of the eggs were deposited on the middle shoots, and that the great majority of them were crushed by rubbing. The operation, though slow, is not necessarily very expensive, as a man could go over approximately an acre a day without difficulty.

We have also conducted some experiments to test the resistance of the eggs to insecticides and have learned that a whale oil soap solution, 1 pound to 4 gallons of water, has no effect on them. It is doubtful if they can be destroyed with a spray. The extended period during which eggs are deposited, however, renders Mr Barden's method of controlling the insect of somewhat questionable value, and its employment can be advised only when a vineyard is found to be badly infested with eggs, and there is, therefore, no other method of getting at the insects before the grubs commence their operations.

Pulverizing the soil and mounding. Prof. F. M. Webster, as a result of his studies, advised thorough cultivation of the soil during the hatching period, taking special pains to keep it banked up over the roots. Professor Webster's idea was that the young insects dropping in the dry sand would be quickly destroyed wherever exposed to the sun, that the looseness of the surface layers would prove a serious hindrance to their burrowing, and that the increased depth over the roots would also provide an additional barrier to the grubs. Thorough cultivation is undoubtedly a most excellent thing, and the additional vigor arising therefrom is a valuable asset in enabling the vine to withstand very serious injury. Our experiments on the traveling and burrowing powers of these little grubs, however, lead us to believe that this measure, so far as preventing access to the roots is concerned, is not of much value. This is confirmed somewhat by the experience of Mr T. S. Clymonts, who states that a seriously injured vineyard can be renewed by thorough cultivation, and that he has experienced no difficulty in doing this with flat cultivation. In fact, Mr Clymonts is of the opinion that mounding the earth about the vines is injurious in other ways and therefore does not advise it. He recommends cutting back the vines to the living wood, enriching the land liberally with stable manure and applying about a barrel of salt to the acre. Then he cultivates with a disk harrow or other tool which will not stir the earth to a great depth, since he believes that deep plowing cuts off a large number of roots and is very injurious to the vines. He states that in several cases known to him where this has been done and flat culture adhered to, badly damaged vineyards have been restored to a very satisfactory condition.

Carbon bisulfid. Prof. F. M. Webster instituted some rather extensive experiments with carbon bisulfid against this insect, and the summary of his results is as follows. He found that the substance could not be used to advantage in soil that was very dry or saturated with water, and that it must be used in that which is damp. He states that the most satisfactory results will probably follow its use in the spring, in a damp soil, when it is applied in such a manner as to fumigate the

roots without the fluid coming in contact with them. He recommends from 4 to 6 ounces for each vine and states that it is not possible to kill every worm about a vine, and that it is doubtful if the low price then current for fruit would justify its use. Growers in the vicinity of Cleveland have not used this insecticide to any extent since the time Professor Webster made his experiments, and they give the high cost as the reason for its not being adopted. It should also be added that considerable care is necessary or the vines will be severely injured.

Kerosene emulsion. Several writers have advised killing the grubs at the base of the vines by the use of a kerosene emulsion, which is to be washed to a greater depth by copious watering or subsequent rain. We have seen very few cases where the grubs were congregated sufficiently to warrant any attempt at killing them in this manner, and it hardly appears practical in a large vineyard.

Crude petroleum. It was hoped that it would be possible to destroy the grubs of this pest by the application of this substance to the soil, and there seemed a chance of using it to prevent the young larvae from making their way to the roots. Some experiments in the office, however, demonstrated that the grubs easily penetrated soil which had the surface layers moistened by a fine spray of the oil, specially if placed on the soil 30 minutes to half a day or more after treatment. This substance appears to have very little value in controlling this insect.

Effect of calcium carbid refuse on grubs. Our attention was called to this substance by the statement that it had proved very valuable against the Phylloxera in France. Some of the material was kindly sent us from the Union Carbide Co.'s plant at Niagara Falls, and various experiments with the grubs were tried. One part of this substance mixed with 10 pounds of soil was placed in a box and some grubs added. One was dead the next day after having burrowed about $\frac{1}{4}$ inch and two others went to the depth respectively of $1\frac{1}{4}$ and 2 inches. No additional fatalities occurred even after 10 days. Several other experiments gave the same general results, and apparently we can have no hopes of this substance being of value in this particular case.

Recommendations. Apparently no one method can be relied on to control this insect, and our recommendations may be summarized as follows. Plan cultural operations so that a firm ridge of earth may be horse-hoed from the vines or otherwise cultivated or disturbed when the great majority of the insects are in the pupal stage and take special pains to stir the soil thoroughly in the near vicinity of the stem. Thorough cultivation and well enriched soil will do much in aiding the vines to withstand attack. This, supplemented by collecting beetles, particularly with a device which will catch them without the delay incident to stopping at each vine, is advisable on badly infested areas during the first two weeks after the adult insects appear in any numbers. The latter may possibly be supplemented or replaced by thorough spraying with an arsenical poison, preferably arsenate of lead, when the beetles begin to appear. Evidence at hand regarding spraying for this insect is not satisfactory, and for the present we prefer to limit our indorsement to above named methods of known value. We believe that these two courses, intelligently applied, afford a most feasible and thoroughly practical solution of the difficulty.

BIBLIOGRAPHY

1886 **Walsh, B. D.** Pract. Ent. 1:99. (Injurious in Kentucky)

1867 —— Pract. Ent. 2:87–88, fig. (Original description and observations on habits and allied species)

1867 —— Pract. Ent. 2:118. (Injurious in St Louis and Bluffton Mo.)

1868 **Riley, C. V.** Noxious, Beneficial and other Insects of Missouri. 1st Rep't, p.132–33. (Brief general notice); same in Mo. State Board Agric. 4th Rep't 1868, 1869.

1870 —— Amer. Ent. and Botanist, 2:307, fig. 188. (Received from Bunker Hill Mo.)

1872 **Kridelbaugh, S. H.** Ia. State Hort. Soc. Rep't 1871, p.159. (Injurious to leaves, remedies)

1873 **Crotch, G. R.** Acad. Nat. Sci. Phila. Proc. 24:33-34. (Described as F. murina)

1879 **Stout, O. E.** Kan. State Hort. Rep't 9:89. (Brief notice)

1885 **Lefevre, Ed.** "Catalogus Eumolpidarum" Soc. Roy. Sci. Liege Mem. Ser. 2, v.11, separate, p.76. (Described as F. lurida)

1892 **Horn, G. H.** Amer. Ent. Soc. Trans. 19:198. (Synonymy and distribution)

1894 **Howard, L. O.** Insect Life, 7:48. (Injurious in Ohio)

1894 **Webster, F. M.** Ohio Agric. Exp. Sta. Newspaper bul. 140; Ohio Farmer, Sep. 27, p.257. (Injurious at Lawrence, Kan.); —— Oct. 4, p.277. (Injuries in Kansas); —— Oct 25, p.337. (Life history and results of experiments); —— Nov. 1, p.357. (Carbon bisulfid and enemies); —— Dec. 6, 27, p. 453, 505. (Remedial measures, distribution)

1895 **Dille, W. W.** Ohio Farmer, June 20, p.497. (Review Walsh & Riley life history, completes life history); —— July 11, p.37. (Results of experiments)

1895 **Webster, F. M.** Ohio Agric. Exp. Sta. Bul. 62, p.77–95. (Detailed account of investigations); Ohio State Hort. Soc. An. Rep't 1894–95, p.16–19. 1pl. (Summary account); Ohio Farmer, Aug. 22, p.147. (Identified from Kansas)

1896 **Marlatt, C. L.** U. S. Dep't Agric. Yearbook 1895. p.391–93. (Brief general account)

1896 **Murtfeldt, M. E.** Colemans Rural World, March, p.97.

1896 **Smith, J. B.** Ent. News, 7:82–83. (Comments on value of arsenical poisons)

1896 **Stinson, J. T.** Ark. Agric. Exp. Sta. Bul. 43, p.114–16. (Injurious in Arkansas. Brief notice)

1896 **Webster, F. M.** U. S. Dep't Agric. Div. Ent. Bul. 6 n. s. p.69. (Decrease in numbers possibly due to egg parasites and a mite)

1897 —— **& Mally, C. W.** U. S. Dep't Agric. Div. Ent. Bul. 9 n. s. p.44–45. (Tobacco dust and kainit ineffective)

1898 **Marlatt, C. L.** U. S. Dep't Agric. Farmers bul. 70, p.9–11. (Reprint from yearbook for 1895)

1899 **Lugger, Otto.** Minn. Agric. Exp. Sta. Bul. 66, p.223–24. (Brief notice); same in Ent. State Exp. Sta. 5th Rep't, p.139–41.

1899 **Webster, F. M. & Mally, C. W.** U. S. Dep't Agric. Div. Ent. Bul. 20 n. s. p. 70. (Insect unusually abundant, serious injuries at Bloomington Ill.)

1900 **Slingerland, M. V.** Cornell Univ. Agric. Exp. Sta. Bul. 184, p.18–32. (Record of injuries in New York and general compiled account, after Webster)

1900 **Smith, J. B.** Insects of New Jersey, p.303. (Occurs throughout New Jersey and on Staten Island on grape and Ampelopsis)

1900 **Webster, F. M.** Ohio State Hort. Soc. Rep't 1899, p.771. (Arsenate of lead apparently very effective)

1901 **Howard, L. O.** U. S. Dep't Agric. Div. Ent. Bul 30 n. s. p.97. (Serious injuries at Bloomington Ill., continued)

1902 **Felt, E. P.** Country Gentleman, May 15, 67:413. (Brief general account with outlines of proposed experiments); —— July 10, p.574–75. (Pupae readily destroyed by cultivation); State Entomologist. 17th Rep't 1901, 1902, p.733–34, fig. 8 (established about Ripley, collected about Albany in 1880), p.837 (partial bibliography); same in East. N. Y. Hort. Rep't. 6th An. Meeting 1902, p.215–16; U. S. Dep't Agric. Div. Ent. Bul. 37 n. s. p.102–3. (Injuries in Chautauqua grape belt)

1902 **Slingerland, M. V.** Cornell Univ. Agric. Exp. Sta. Bul. 208. (Investigations and remedies)

1903 **Felt, E. P.** N. Y. State Mus. Bul. 59, p.49–84. (Detailed account, specially of recent work); same in Grape Belt, issues for Jan. 9, 13, 20, 27 and Feb. 3 and 10; Country Gentleman, Mar. 19, 68:255. (Corrects reported error); N. Y. State Fruit Growers Ass'n. Rep't. 1903, p. 94. (Brief account); Grape Belt, June 16, p. 2. (Remedial measures); American Agriculturist, June 20, 71: 648. (Injuries and remedies); Grape Belt, June 26, p. 1, 6. (Habits of beetles, efficiency of destroying pupae, value of beetle catchers); Grape Belt, June 30, p. 4. (Beetles bred from two vines, efficacy of catchers); Grape Belt, Sep. 4, p. 1. (Brief summary of observations and experiments); same in Jamestown Journal, Sep. 4, p. 1; also in Country Gentleman, Sep. 24, 68:828; Grape Belt, Oct. 20, p. 1. (Results obtained by collecting beetles and spraying)

1903 **Slingerland, M. V.** Grape Belt, June 19. (Summary of present conditions)

1903 **Spencer, J. W.** Grape Belt. July 24. (Results with arsenate of lead)

EXPLANATION OF PLATES

Plate 1[1]

1 Beetle, much enlarged
2 Leaf badly riddled by the beetle
3 Eggs on last year's wood; the loose bark has been lifted so as to expose them
4 Larva or grub, much enlarged
5 Work of larva or grub on larger roots
6 Pupa or "turtle stage" in cell
7 Same much enlarged

Plate 2

1 Vineyard somewhat injured by Fidia, August 1903
2 Healthy vineyard with vigorous foliage, August 1903

Plate 3

Vineyard badly injured by the grapevine root worm. Observe that very few of the vines extend to the top wire. The wires and posts would ordinarily be concealed in a thrifty vineyard.

Plate 4

Vineyard more seriously infested than the preceding. A portion of this was uprooted last spring, and the area shown was kept simply for experimental purposes.

Plate 5

Portion of two vines represented on the preceding plate and showing how badly the beetles may eat the foliage when abundant.

Plate 6

Leaves from badly eaten vine, illustrating the peculiar, chain-like eaten areas

Plate 7

Breeding cages, distant view, showing also the general condition of the experimental area, June 1903

Plate 8

Breeding cages, near view, showing general condition of the vines near by, June 1903

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[1] Executed from nature under the author's direction by L. H. Joutel.

Plate 9

Beetle catcher devised by Messrs Hough and Barden

Plate 10

Morehouse beetle catcher

Plate 11

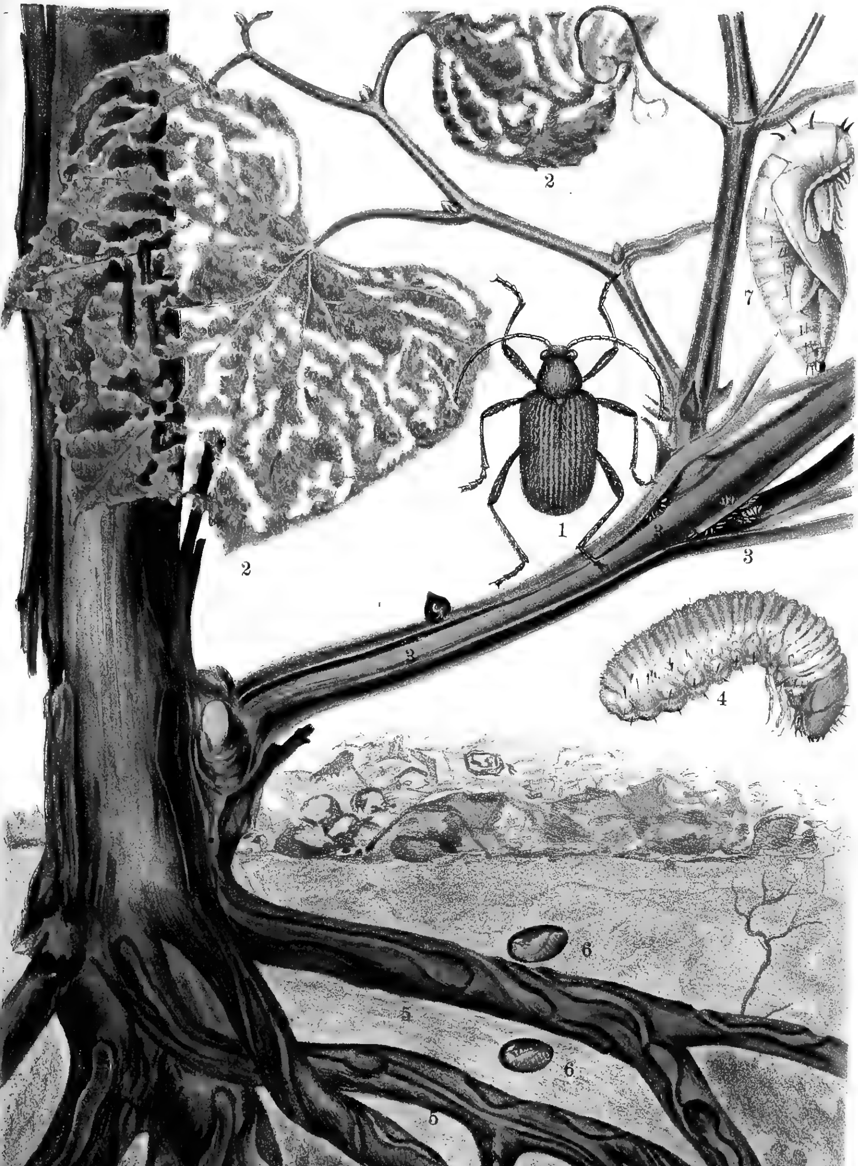
Morehouse beetle catcher

Plate 12

Morehouse beetle catcher in operation, June 30

Plate 13

Blowers collecting machine



L. H. Joutel, 1902

Grapevine root worm

Photo August 1903

1 Vineyard somewhat injured by root worm

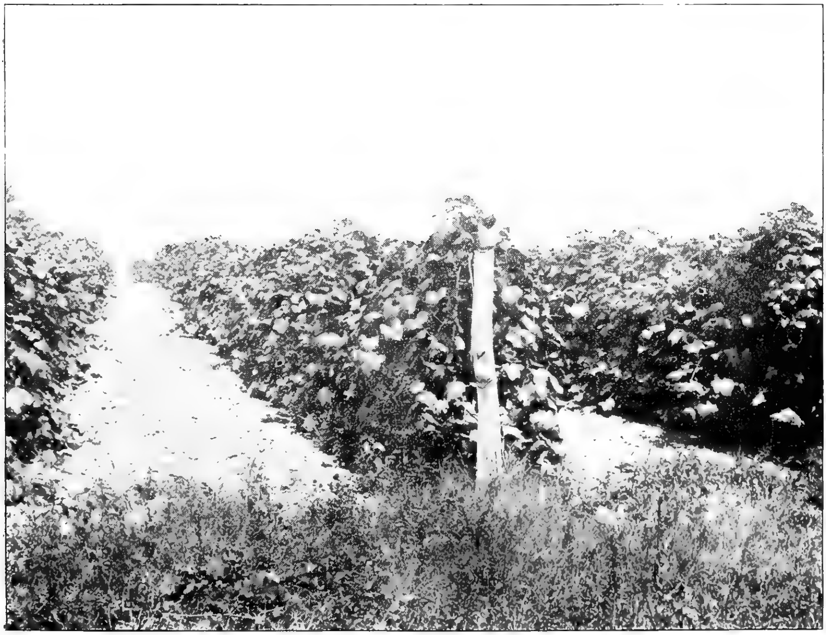


Photo August 1903

2 Healthy vigorous vineyard

Photo Aug. 15, 1902

Vineyard badly injured by grapevine root worm (The vines should cover the wires and posts.)

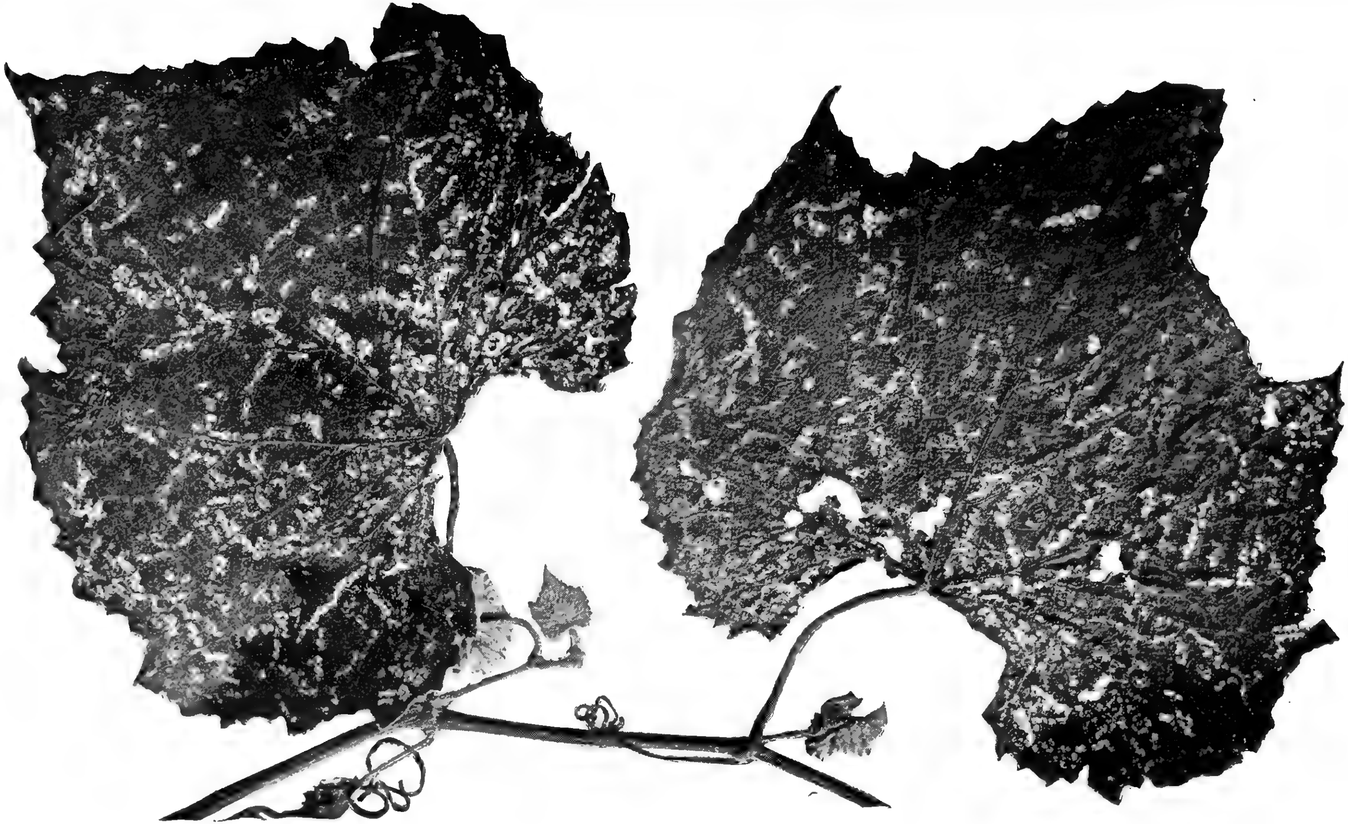
Plate 4

Photo Aug. 15, 1902

Vineyard very badly injured by grapevine root worm (This piece was torn out by the owner as worthless.)

Photo Aug. 15, 1902

Foliage badly eaten by beetles



Leaves from badly eaten vine, illustrating the peculiar chainlike eroded areas

Plate 7

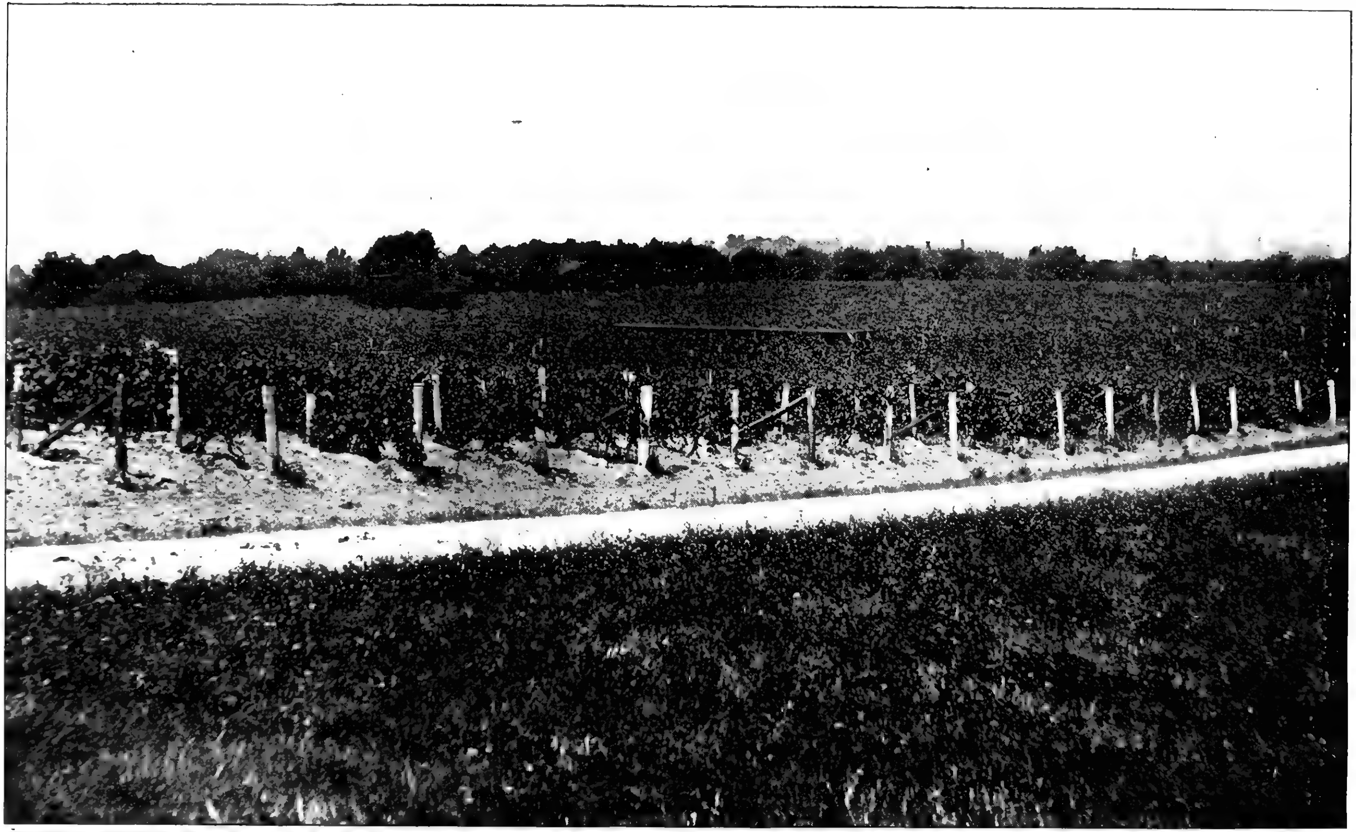


Photo June 1903

Experimental vineyard and breeding cages near center

Photo June, 1903

Nearer view of breeding cages

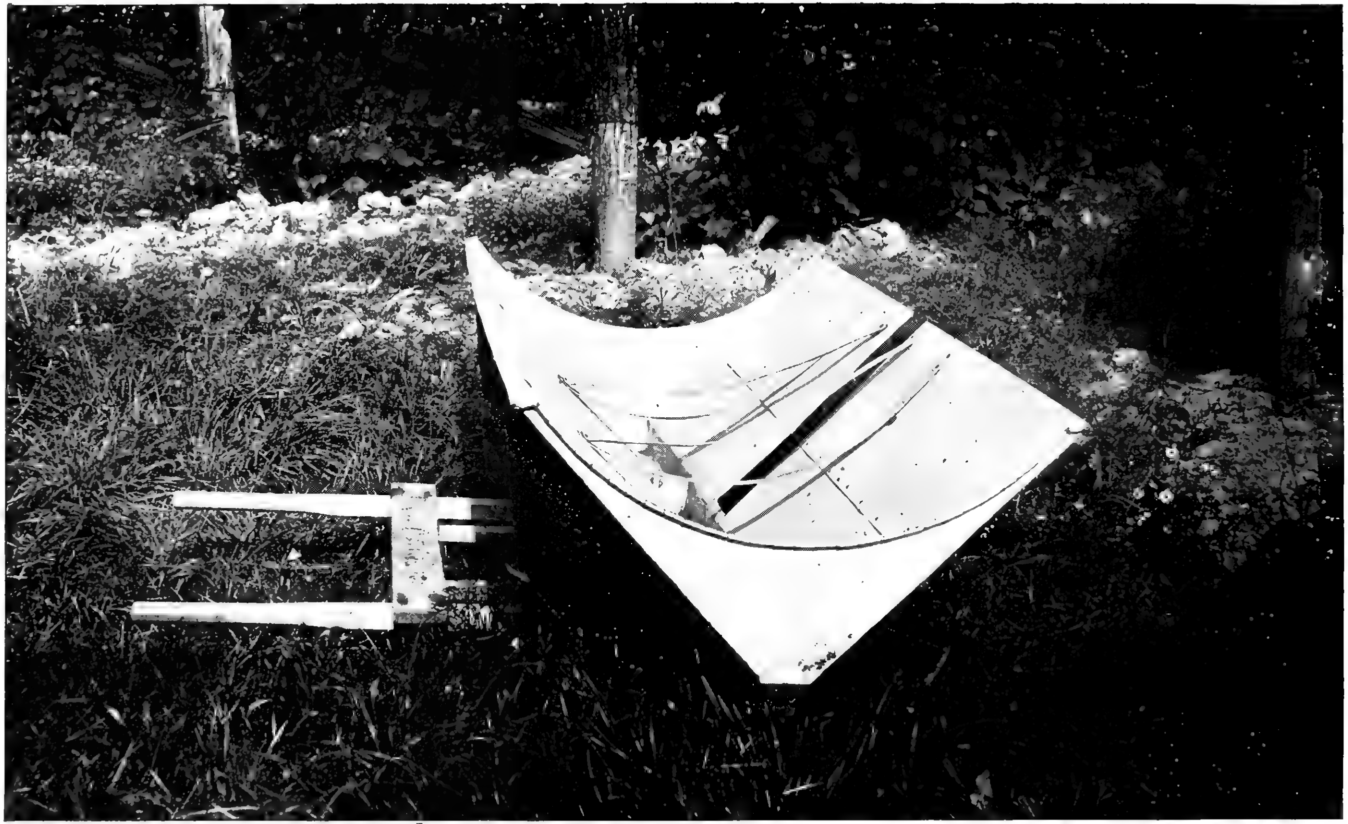


Photo Aug. 15, 1902

Hough beetle catcher

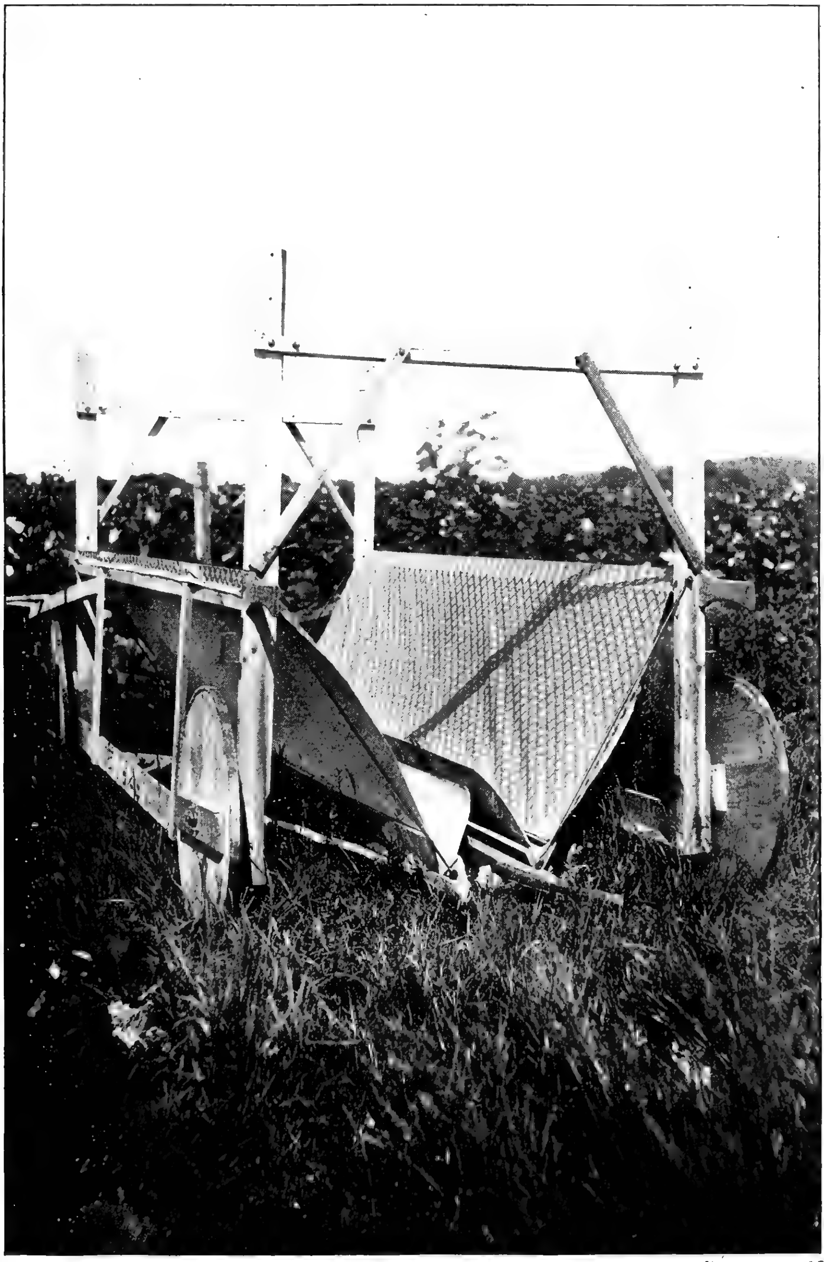


Photo June 1903

Morehouse beetle catcher

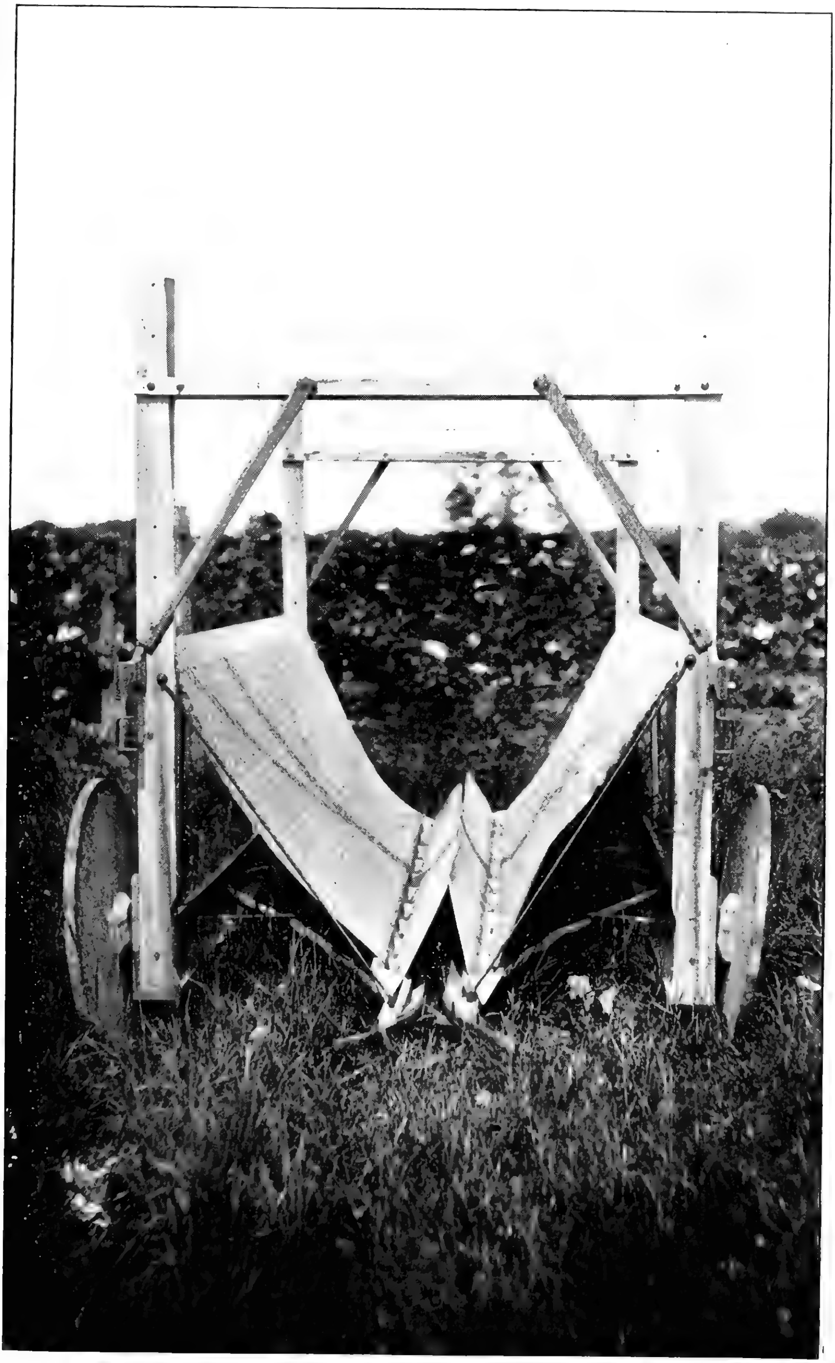


Photo June 1903

Morehouse beetle catcher

Morehouse beetle catcher in operation

Photo June 1903

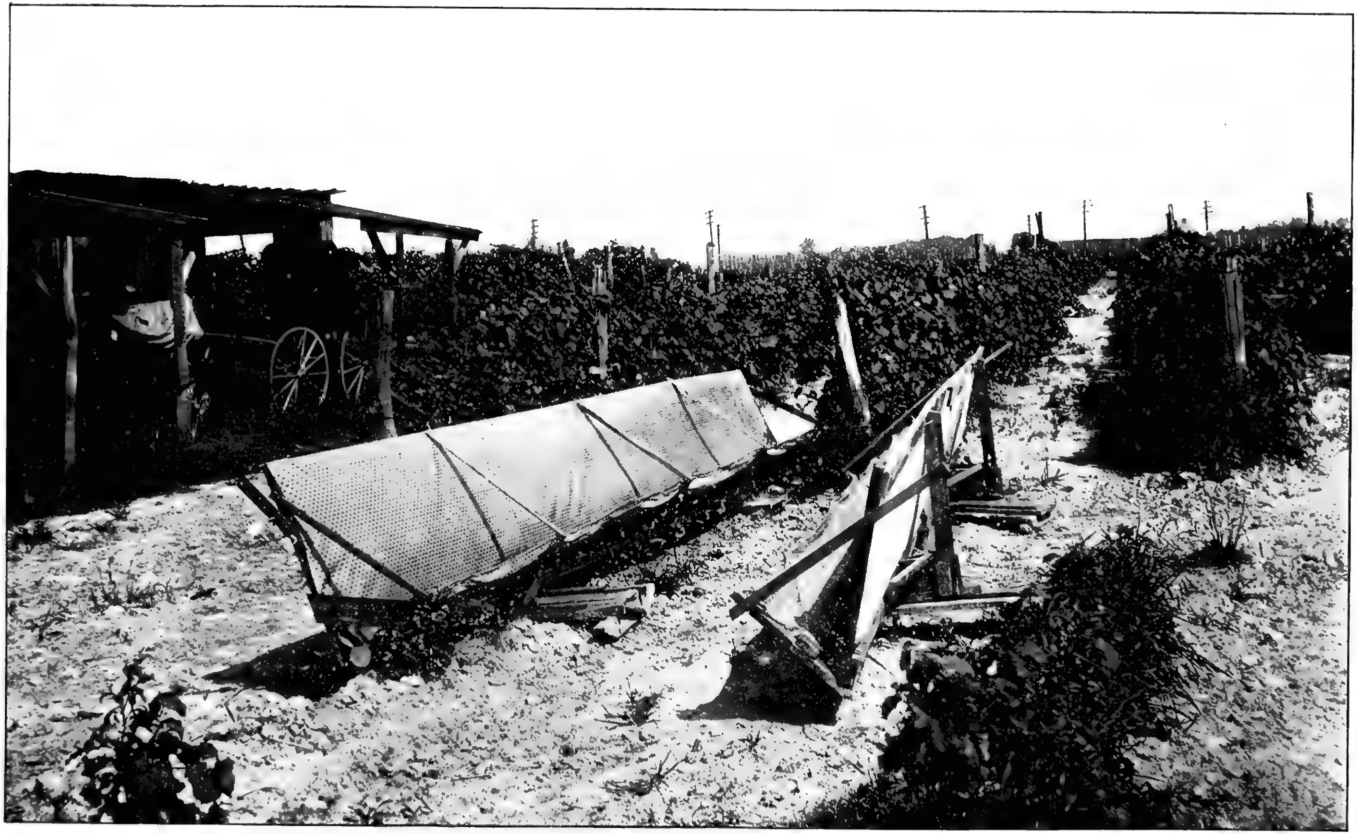


Photo August 1903

Blowers beetle catcher

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University of the State of New York

New York State Museum

PUBLICATIONS

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Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

The annual reports of the early natural history survey, 1837–41 are out of print.

Reports 1–4, 1881–84 were published only in separate form. Of the fifth report four pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15, 2v.	2	18	.75	21	.40

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Since 1901 these reports have been issued as bulletins.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–17 bound also with museum reports 40-46, 48-55 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4 are out of print other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
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2	.30	9	.25	14 (Ent. bul. 5)	.20
5	.25	10	.35	15 (" 9)	.15
6	.15	11	.25	16 (" 10)	.25
7	.20	12	.25	17 (" 14)	.30
				18 (" 17)	.20

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21-date of which they form a part; the first botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports 25-28, 30, 42-50 and 52 (Botany bulletin 3), are out of print. Report 51 may be had for 40c; 53 for 20c; 54 for 50c; 55 (Botany bulletin 5) for 40c; 56 (Botany bulletin 6) for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st, 52d, 54th and 55th reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy, general zoology, archeology and miscellaneous,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4
				49–54	55, v. 1

The figures in parenthesis indicate the bulletin's number as a New York State Museum bulletin.

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G2 (19) Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [*50c*] *New edition in preparation.*

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il 9pl. map. Dec. 1901. *25c.*

G5 (56) Merrill, F: J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. *10c.*

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—— Crystalline Rocks of the Northeastern Adirondacks *In preparation.*

Kemp, J. F. Crystalline Rocks of Warren and Washington Counties. *In preparation.*

Woodworth, J. B. Glacial Geology of New York *In preparation*

Economic geology. **Eg1** (3) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

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En17 (64) —— 18th Report of the State Entomologist 1902. 110p. 6pl. May 1903. *20c.*

En18 (68) Needham, J. G. *& others.* Aquatic Insects in New York. 322p. 52pl. Aug. 1903. *80c, cloth.*

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This is a revision of En16 containing the more essential facts observed since that was prepared.

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Museum memoirs 1889-date. Q.

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2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. *$1, cloth.*

3 Clarke, J: M. The Oriskany Fauna of Becraft Mountain. Columbia Co. N. Y. 128p. 9pl. Oct. 1900. *80c.*

4 Peck, C: H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. *75c.*
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5 Clarke, J: M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. *$1.50, cloth.*

6 —— Naples Fauna in Western New York. *In press.*

Felt, E. P. Insects Affecting Park and Woodland Trees. *In preparation.*
Merrill, F: J. H. Geology of New York City and Vicinity. *In preparation.*
Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. *In preparation.*

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